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FOR PROMOTING EXPERIMENTS IN
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EAST MALLING RESEARCH STATION

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Goods Station: Aylesford (Southern Railway).

Bus Services:

FROM MAIDSTONE by the Maidstone and District Motor Services Limited, every 20 minutes from Maidstone to East Malling Church.

FROM LONDON a regular service of Maidstone and District Coaches from the London Coastal Service Limited, Victoria Station, may be of assistance to Visitors. The Coaches call at East Malling on certain inward and outward journeys.

For Visitors coming by road DITTON CORNER on the main London-Maidstone Road (with Red Lamp Danger Signal) is the turning to the Research Station.

Telephone: Aylesford 7229.

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is accommodated at East Malling Research Station.

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EDITORIAL

THE Station's Annual Reports are now published in two parts. That dealing with the general development and activities is presented by the Executive Committee to the Annual General Meeting; it is now printed as a Supplementary pamphlet mainly for the use of our Committee and Members, and is circulated separately to our Members.

The Annual Report of research work is made up of four sections as follows:

I. The Experimental Farm.
II. General Review of Research Work, with Summaries of Papers published during the Year.
III. Preliminary Research Reports.
IV. Bulletins for Fruitgrowers.

Section II includes complete lists of papers published by the staff during 1934, together with summaries of those papers not readily accessible to our Members. Papers published in our Annual Report for 1933 are mentioned in the lists but not summarized since they are either already in the hands of our Members, or can be purchased from the Station.

This year Dr. Wormald has very kindly undertaken the general editorial work of the report in addition to that of his own Section, and he has promised to act as general editor in future years.

R. C. KNIGHT, D.Sc. (Lond.), D.I.C.

AN APPRECIATION

R. C. KNIGHT, D.Sc.(Lond.), D.I.C.

(Deceased January 28th, 1935)

SCIENTIFIC horticulture has suffered a heavy loss by the early death on January 28th of Dr. R. C. Knight, Assistant Director of the East Malling Research Station. He was born in 1891 and was educated at Sexey's School, Bruton, and at the University of Bristol where he took a degree in Botany. He obtained a Board of Agriculture Research Scholarship in Plant Physiology in 1916, which he held at the Imperial College of Science and Technology, and in 1919 he was appointed to the staff of the Research Institute of Plant Physiology of that College. His early work was on transpiration, his association with East Malling Research Station beginning in 1920 when the striking examples of rootstock influence upon the scion already demonstrated opened up a promising field for physiological investigations. At the instance of the Ministry of Agriculture and with the warm approval and encouragement of Professor Blackman, Knight began to visit the Station for short periods to familiarize himself with the problem and to collect the necessary material. His object was thus to be able to explore the possibilities of classifying physiologically those hard-wood perennials which had shown such striking morphological and pomological differences.

By 1922 it became obvious that in order to push forward with the work he must live on the spot with his material, maintaining meanwhile his contacts with the main stream of physiological thought by periodical visits to the Imperial College of Science and Technology, where indeed he remained a member of the staff right up to his death.

He entered into his new life in a country laboratory with a zest which never flagged even through the later years of prolonged illness and fatigue.

Knight's interests were so wide that he rapidly absorbed the horticultural problems which were being investigated around him, and although he often said that these early years were " spent in closing doors by obtaining negative results rather than in opening them ", this was an essential preliminary exploration and he was all the time evolving in his mind and discussing with his colleagues those " physio-pomological " methods which he used so much in later years. Indeed he was a leader in realizing that if Plant Physiology was ever to be applied to practical problems it could not be kept separate from Horticultural Science or Pomology. In this respect he might almost be regarded as supplying the link between the plant physiologist and pomologist, and as outlining the mental equipment necessary for the modern horticultural scientist. He not only made himself a competent horticulturist, but he also exercised a great influence in moulding the younger generation of plant physiologists who were going out to apply their knowledge to very diverse practical problems. Yet all the time that Knight was patiently adapting his physiological knowledge and technique to a complex race of fruit plants with which until then he had been quite unfamiliar, he was closely watching the empirical horticultural experiments and traditional practices in progress around him. While developing his ideas and accumulating material for his "long shots " at a physiological elucidation of the relationships between stock and scion, he applied himself wholeheartedly to the practical problems of vegetative propagation.

He did indeed much careful work in determining the optimum conditions for raising hard and soft-wood cuttings, but his outstanding contribution was concerned with the practice of layering. Here he emphasized and elucidated the all-important part played by the etiolation of the base of the shoot in encouraging adventitious rooting. By drawing attention to this aspect, he made it possible to reproduce with much greater certainty clonal races of a far wider range of plants than had been possible heretofore. For his interests were not bounded by the deciduous plants around him and coming into contact with many plant physiologists working on horticultural problems throughout the Empire he delighted to discuss with them similar problems in tea, coffee, rubber and other plants.

While by ingenious adaptations of the horticultural technique of double grafting and by the use of "multiple" root systems, Knight was trying to evaluate the parts played respectively by the actual root system and the stempiece of the rootstock, he was familiarizing himself meanwhile with his less complex material by a study of the shoot-root relationship and the chief times and regions of cambial activity and stem thickening in trees of different ages and species. All the time he was considering how his results might be applied to improving the methods used in such ordinary horticultural practice as the treatment of nursery trees and pruning after transplanting. One of the crying needs of horticultural science to-day is a full picture of the fruit plant and its interactions. Whilst many of the physiological data collected by himself and other workers still remain to be pieced together into one coherent whole, there is no doubt that Knight's work will form an integral part in that picture which when complete must contribute not only to general botanical knowledge but also to the precision of horticultural practice.

But Knight's contribution to Horticultural Science is in no way adequately measured by the twenty or more published reports standing under his name. He exercised a profoundly stimulating influence not only upon his immediate colleagues, but upon the large number of graduate workers and investigators on leave from overseas who visited the Research Station for long or short periods. In recent times he acted as director of studies to a number of these workers, and his ready sympathy and wide understanding placed him naturally in the position of general consultant not only to the students, but to the whole of the staff. He was never too busy to listen, and, although his critical faculties were very strongly developed, his criticisms were invariably helpful and constructive and were made in a way which never hurt. His clarity of view gave him that gift of bringing out the best in other people's work by suggesting alterations in emphasis and clarification of ideas.

If ever a man succeeded in maintaining two loyalties it was Dr. Knight. Professor Blackman made this as easy as was humanly possible for him, and, in consenting to his taking on the responsibilities of Assistant Director at East Malling Research Station gave his blessing to a collaboration which Knight's temperament made both happy and productive. Although he did not actually assume this position until the extension of the Research Station in 1927, Knight had become the confidant and consultant of the Director much earlier and helped in building upon the foundations of the programme, personnel and equipment which made possible the rapid developments of the past ten years.

Knight's outstanding abilities were perhaps to some extent hidden by his unassuming nature and genial manner. Even to his closest friends it became difficult to assess adequately the part he played in the Station's history and in the wider sphere of the development of Horticultural Science. Both causes were dear to him and he was so quick to seize, or throw out, a new idea, so ungrudging in giving his contribution

to its development, so willing to get down to details and work them out meticulously, that he has left an enduring influence upon every phase of the Research Station's activities. He took a large share in the development of its general programme of investigations, its experimental technique, its corporate social life, and its external contacts with overseas workers. Much of his thought and care is built into the structure and equipment of the laboratories and library, but long after these are forgotten his colleagues will still remember his informal methods of evoking stimulating discussion, his unobtrusive readiness to give good counsel and frank criticism, and his gift for inspiring confidence.

Section I

THE EXPERIMENTAL FARM

By J. AMOS, F. H. BEARD, M. H. MOORE AND A. C. PAINTER
WITH INTRODUCTION BY R. G. HATTON

INTRODUCTORY.

We would once again repeat the remarks which have formed the introduction to this section of the report in previous years, as it is very necessary to bear them in mind when considering the results obtained.

The total area of the Research Station is now approximately 138 acres (Great East Field 22 acres, Egham Field 40 acres, Church Fields 20 acres, Newgates Field 25 acres, Upper Grub and Newgates Shaw 13 acres, and, in addition, a rented piece in Kiln Field comprising 18 acres). However, quite a considerable proportion of the area (approximately 10 acres) is occupied by buildings, approaches, innumerable headlands to comparatively small experimental plots and even to planted areas which can never be commercially productive (approximately 6 acres). In addition, many of the plantings (approximately 40 acres) are still quite young and are producing no returns. Again, varieties of problematical commercial value have frequently to be deliberately chosen for planting in order to study the very troubles for which the grower is seeking an explanation. Finally, even amongst the yielding areas there are inevitably the "control" plots, the unpruned, unsprayed, unmanured, etc., which bring down the standard of the whole. The picking and marketing is often complicated by the very large number of varieties grown and the small plots into which many of the trials are divided, e.g. strawberry and raspberry trials may consist of as many as 300 to 400 separate plots, each of which has to be picked and recorded separately, thus appreciably increasing the cost of picking and the amount of handling, which, in its turn, renders it difficult to get the fruit on to the market in the best condition.

Owing to all these experimental exigencies it is only on comparatively small areas that our own ideal routine of cultural and spraying methods can be carried out. We would ask our grower readers to bear all these foregoing facts in mind in judging the results on an experimental farm. East Malling must not be looked at as a farm mainly demonstrating how things should be done; only too often the right ways can only be found out after eliminating a succession of wrong ones, and it yet remains for some Educational Authority to demonstrate on a commercial scale the combination of right findings of research and put them in their economic frame. This point of view is being emphasized because we believe that our annual report on the farm could profitably be developed in more detail than heretofore, provided it is realized that we are not claiming to tell the story of a commercial holding run on up-to-date lines, but merely to state in terms of market value some of the experiences gained from the sale of fruit from our experimental plots. (R.G.H.)

FARM REPORT

Cultural.

Following the very dry season of 1933, the early months of 1934, although not entirely lacking in rainfall, were notably dry and conditions were generally ideal for most farm operations. Temperatures during January, February and March were generally low and in consequence the season was an average one as regards the opening of the blossom. Most varieties of top fruit were in flower during April and the first half of May; during this period warm, sunny weather was experienced and no severe frosts occurred. Almost without exception all kinds of fruit produced an abundance of blossom, setting very heavy and, in many cases, record crops. The weather during June and July was mainly hot and dry, and, although some rain fell, drought conditions generally prevailed. This hastened the ripening of the fruit and picking commenced early. As an example of this the gathering of sweet cherries, which in a normal season commences about the 20th of June, commenced this year on the 7th and finished early in July. August was somewhat variable, dull periods being experienced, together with many low temperatures at night. Owing, however, to the dry and mainly hot conditions, apples and plums again ripened early, the bulk having to be harvested quickly during September and early October. This rapid ripening of the fruit was the cause of considerable fruit drop (particularly in the case of apples)—such as is rarely seen, except after a severe gale. In spite of this abnormal "drop" a heavy tonnage was gathered in sound condition. October was mainly dry and it was not until late in November that any appreciable amount of rain fell and the ground became moist enough to start lifting nursery stock, etc. In contrast to the rest of the year December was notable for its very heavy rainfall, some 5 inches being recorded. This almost continuous rainfall made winter spraying impossible, but it did assist other operations such as grubbing and the lifting and transplanting of a series of sixteen-year-old apples to more permanent quarters.

Fresh Plantings, Grubbings, etc.

Great East Field.—Owing to overcrowding, two rootstock trial plots of sixteen-year-old Bramley's Seedling and Worcester Pearmain have had to be thinned. When these were planted it was intended that the Bramleys should remain as the permanent trees, the Worcesters acting as fillers. However, in order to preserve a set of Worcesters upon the complete series of rootstocks, on one plot the Bramleys have been grubbed. On the other plot the Bramleys have been left and the Worcesters lifted and transplanted into the places from which the Bramleys on the former plot were taken out. This now gives a full plant of Worcester at 15 feet square. The transplanting of this set of trees will enable information to be obtained as to the response of the various rootstocks at sixteen years of age to this treatment.

Further grubbing has been the clearing of half an acre of plum varieties on the Museum, and one acre of second-class apple varieties from the old Pruning Plot. These two areas are being prepared and are already reserved for the planting up of small-scale strawberry trials. About a quarter of an acre of Logan and Blackberry varieties has also been grubbed and has been replanted with maiden trees of Cox's Orange Pippin to be grown as cordons in order to study this form of culture in relation to rootstock effect, pruning, manuring, etc.

Egham Field and Church Field.—On these fields no further planting of bush or top fruit has been done. On the latter field an acre has been prepared for the planting up of a Logan and Blackberry trial, material for which has been raised at the Station from specially selected clone parents.

Newgates and Upper Grub.—On the Newgates field an acre has been specially prepared and planted with new raspberry varieties raised at the Station. It will be used to study cropping in relation to various manurial treatments. The two acres of mosaic-free Lloyd George raspberry, left for the raising of canes, produced an abundant crop of first-class material. Most of the canes were lifted and distributed to growers, but sufficient was left in the rows and will be cropped during the coming season. The five acres of Royal Sovereign which gave a heavy crop in 1933 was seriously affected by the drought and gave a considerably reduced yield. The only grubbing on this field has been an acre of ten-year-old Lloyd George raspberry canes previously used for spraying trials ; this plot has been replanted with nursery material.

Upper Grub.—One acre of Black Currant seedlings has been grubbed and the area heavily manured, ploughed, subsoiled and replanted with strawberry runners of Royal Sovereign raised from our selected clone families. This plot is somewhat isolated from the rest of the farm and it is hoped to be able to raise in quantity, and keep free from disease, material for our contemplated large-scale strawberry experiments. A further planting has been a quarter of an acre with trees, some of which are upon their own roots, the others worked upon two different rootstocks. The remainder of this field is now fully occupied by stool and nursery beds.

Kiln Field.—The past season was an ideal one for cleaning up this new addition to the Station. The response of the trees to cultivation and thorough spraying was most marked, and practically all varieties produced a heavy crop of clean fruit, much of which was of first-class quality.

The section consisting of Bramleys interplanted with early cooking varieties is being gradually thinned and a number of the Bramleys are being grafted in various ways with other varieties to provide for pollination. This field is already being used for experimental spraying.

We would like to take this opportunity to thank those who have kindly come to the assistance of the Station by the loan of implements, etc., in particular Mr. William Rogers, of Horton Kirby, for the use of grubbing tackle, and Mr. H. E. Bennett, of Ditton Court, for the use of drills, etc. (J.A.)

Marketing.

The year was notable for the heavy crops of almost all kinds of fruits with which the markets were flooded from July to December. This refers mainly to plums and apples, the yields of which were in all probability the highest on record, prices, in consequence, being depressed to a level at which only the best quality fruit could be said to be a paying proposition. This was especially the case with cooking apples and with plums, which in many instances were almost unsaleable although in a normal year they might have been expected to fetch quite a good price. Pears, on the other hand, found a readier market, though at lower prices than in previous years.

Soft fruits fared better. Whilst the price of raspberries was low, that for strawberries was distinctly good though counterbalanced to a great extent by a light crop.

Red currant prices remained good, and those for black currants and gooseberries, though lower than last year, might be said to be satisfactory in view of the larger yields. Morellos were another crop that paid well.

Facilities for storing and packing were vastly improved by the erection of a packing shed 80 ft. × 60 ft. housing a large model cutler grader and three gas storage chambers of the latest type, each capable of holding 2,000 bushels of apples. The shed was erected by Messrs. Boulton & Paul, of Norwich, and the gas storage equipment by Messrs. J. & E. Hall, of Dartford.

In a year such as the one under review this proved the greatest boon—indeed without these facilities it is difficult to see how the recording and marketing of the greatly increased crops of apples, pears and plums could have been proceeded with without considerable loss and delay. In addition, large quantities of apples would, of necessity, have been disposed of at prices offering little or no margin of profit. As it is, these same apples are now being brought out of store and marketed at prices that will show a very satisfactory profit even after full provision has been made for the extra cost of storage and for depreciation.

With regard to gas storage, the Station has been most fortunate in having close at hand Dr. Cyril West, of Ditton Laboratory, who has always been most ready to place his expert advice and assistance at our disposal.

Prices, wherever quoted, are gross and are those obtained for the main crop, odd consignments at the commencement and end of the season not being taken into account.

Individual Crops.

Strawberries.—(Area under cultivation—4¾ acres in Newgates Field in their third year, rather more than ¾ acre of which had been originally deblossomed and used for runners. In addition, two small experimental plots in Egham Field, comprising about ½ acre in all. The plantings consist entirely of Royal Sovereign.)

The commercial plantation on Newgates Field had deteriorated considerably since the previous season with the result that the crop was both less and of poorer quality than in 1933, only some 5 tons 13 cwt. being picked against 9½ tons the previous year. The yield per acre after allowing for the rows used for runners was 27 cwt.

The crop was marketed as follows :—

Under the National Mark Label.

"Extra Selected" in 1 lb. punnets—600 lbs. Price 8d. to 1s. 5d. a lb.
"Selected" in 3 lb. chips—3,220 lbs. Price 5d. to 1s. 2d. a lb.

Under Own Label.

Small fruit in 6 lb. chips—3,470 lbs. Price 4d. to 7d. a lb.
Jam fruit in tubs—1,850 lbs. Price 3¾d. a lb.
Ungraded in 3 lb. chips—3,400 lbs. Price 5d. to 1s. 1d. a lb.

The gross amount received was £305 or £53 10s. a ton.

Of the fruit from plots that were graded throughout 51 per cent. was up to National Mark standard, and marketed under that label.

The experimental plots in Egham field yielded approximately 1 ton of fruit which brought in some £53. Owing to the handling necessary in connection with recording, no attempt was made at grading except to exclude damaged and blemished fruit.

Raspberries.—(Area under cultivation—1 acre of ten-year-old, and 2½ acres of one-year-old Lloyd George in Newgates Field, and a small patch of new seedlings in Egham Field.)

The acre of ten-year-old Lloyd George has been used for a spraying trial during the past seven years. It is now in poor condition and only yielded 28 cwt., 25 per cent. of which was marketed in 3 lb. chips, the remaining 75 per cent. being only fit for jam.

Though the quality of the fruit from the 2½ acres of one-year cane was better, 33 per cent. being marketed in chips and 66 per cent. as jam, the yield, 14 cwt. to the acre, was not high. This was due to the dry conditions, and the lack of fruiting cane.

Prices were low, chips fetching from 4d. to 8d. a lb. with a few at a higher level, while jam fruit only made £22 to £25 a ton.

In all, some 3 tons 6 cwt. were harvested at a gross return of £96, or just over 3d. a lb.

Gooseberries.—(Area under cultivation—2 acres in Egham Field interplanted between bush pear trees, and consisting of a variety collection of Careless, Freedom, Greengage, Gunner, Keepsake, Leader, Leveller, White Lion and Whitesmith, the bushes being from six to fourteen years old.)

The fruit was again left to ripen for dessert, this having been found from past experience to be the most profitable course. The crop, though not heavy, was appreciably greater than the previous year, apart from Whitesmith nearly 5 tons of fruit being harvested. In common with most other soft fruits the price was lower than in 1933, the average return being just over 2¾d. a lb. against 3½d. The gross amount received was about the same, viz. £128.

The fruit as usual was graded and marketed almost entirely in chip baskets. The particulars of quantities and prices are again given for the sake of comparison with previous years.

"Selected" in 6 lb. chips (24 to 30 berries to the lb.)—740 lbs.
Price 4d. to 6d. a lb.
Grade 1 in 12 lb. chips (30 to 40 berries to the lb.)—3,250 lbs.
Price 2½d. to 4½d. a lb.
Grade 2 in 12 lb. chips (40 to 50 berries to the lb.)—3,900 lbs.
Price 1½d. to 3½d. a lb.
Grade 3 in 12 lb. chips and half-sieves (55 to 70 berries to the lb.)—2,300 lbs.
Price 1¼d. to 2½d. a lb.
Smalls in half-sieves (80 to 120 berries to the lb.)—700 lbs.
Price 1d. to 1½d. a lb.

As before the yellow berries, such as Gunner, Leveller and Leader and the late variety White Lion sold better than the other berries. This is quite apart from the question of cropping capabilities.

Green thinnings from a thinning experiment and Whitesmith brought in another £6. Only some 8 cwt. of the latter, however, were picked, the greater part being left on the bushes owing to the small margin of profit and to there being more pressing work on hand.

Red Currants.—(Area under cultivation—about ¾ acre interplanted between apple trees and consisting of some twenty odd varieties from nine to eleven years old. Also ¾ acre of four-year-old bushes which is being used for a variety and cropping trial.)

Red currants were a lighter crop than in 1933, the older piece only yielding some 32 cwt. against 3 tons. In addition 10 cwt. were picked from the new piece.

The total gross receipts amounted to £77 giving an average return of just under 4d. a lb. or the same price as has been obtained the last three years. The fruit was marketed in 6 lb. chips.

Black Currants.—(Area under cultivation—a variety trial comprising 1 acre of seven-year-old bushes in Egham Field, 1 acre of new Seedling crosses in Upper Grub and 2 acres of two-year Baldwin and Wellington's Triple X in Newgates Field.)

Black currants, which had failed the previous year owing to frost damage, were a good crop, the seven-year-old bushes in Egham Field yielding 4½ tons, the seedling crosses in Upper Grub 1¼ tons, and the two-year-old bushes in Newgates Field ½ ton to the acre, the total crop amounting to somewhat under 7 tons.

Prices were lower than last year, ranging from 3d. to 6d. a lb. with an average of 4d. The gross amount received was £255. As usual the fruit was marketed in 6 lb. chips.

The new East Malling Seedlings in the variety trial in Egham Field have continued to do well, the average yields per acre compared with the main commercial varieties being as follows :—

	1934.	*Yield per acre. Since Planting.*
Wellington's Triple X	4·8 tons.	16·5 tons.
,, Single X	4·5 tons.	12·9 tons.
,, Double X	3·2 tons.	12·4 tons.
Baldwin	2·8 tons.	12·1 tons.
Seabrooks	3·4 tons.	10·4 tons.
Goliath	4·0 tons.	10·1 tons.
French	3·1 tons.	9·7 tons.
Boskoop	2·5 tons.	7·8 tons.

Cherries.—(Area of Acid Cherries under cultivation—0·4 acre of eleven to thirteen-year-old Morellos, planted at 12 by 12 feet, ½ acre of eight-year-old Morellos, ⅔ acre of seven-year-old Kentish Red and ⅓ acre of Carnation and young Morellos, all at 15 by 15 feet in Egham Field. In addition there is about ¼ acre of Morellos in Newgates Field held at the disposal of the Pathology Section for spraying trials.)

The Morello cherries not only cropped heavily but also yielded fruit of exceptionally good quality, out of a total yield of nearly 5½ tons only some 300 lbs. falling below National Mark standard. Thus practically the entire crop could be marketed under the National Mark label.

The trees that had been dehorned two years ago had made good growth and cropped well. On the whole the fruit was somewhat smaller than that from the trees that had not been dehorned, but as they appeared to have more fruit in proportion to tree size, this was probably the cause.

For the first two pickings the fruit was graded into "Extra Selected", (National Mark), "Selected" (National Mark) and Grade 2, but for the remainder of the season into two grades, "Selected" and Grade 2, the quantities sold being as follows :

"Extra Selected" in 6 lb. chips—700 lbs. Price 5d. to 6d. a lb.
"Selected" in 6 lb. chips—11,270 lbs. Price 3d. to 6d. a lb.
Grade 2 in 12 lb. chips—300 lbs. Price 2¼d. to 3½d. a lb.

The fruit realized in all some £220 or a gross return of 4·3d. per lb.

The Kentish Red cherries gave their first appreciable crop, amounting to 2 tons 17 cwt. or at the rate of approximately 4¼ tons to the acre.

The fruit was graded into two size grades and marketed in 12 lb. chips. The early pickings consisted mainly of fruit of a fair size but in the later pickings the fruit was distinctly on the small side.

Gross receipts amounted to £83 or an average of 3·1d. per lb., prices ranging from 2½d. to 4d. a lb. for the better quality fruit and from 2d. to 3d. for the second grade.

The yield from the variety collection of sweet cherries, viz. 17 cwt., is still quite small, the returns from these together with a few odd sour cherries only amounting to some £37.

Plums.—(Area under cultivation—3 acres of twelve-year and 2 acres of nine-year-old trees in Egham Field, 2½ acres of six-year trees in Church Field, ½ acre of nineteen-year-old trees in Great East, ½ acre in Newgates Field and in addition 3½ acres in Kiln Field.)

Plums were variable. Czars, Pershore Egg and Myrobolans all carried a breakdown crop, but otherwise, though yields were in some instances—notably that of " Victoria "—extremely good, in no case were crops sufficient to render thinning essential. Czars and Pershore Egg were thinned heavily to about 1 inch apart. It would have also probably paid to have thinned the Myrobolans. There was no previous experience, however, as to how these would behave with a heavy crop and it was therefore decided to leave them.

Apart from Kiln Field the total crop amounted to some 29½ tons, an increase of 5 tons over the previous year, the varieties giving the principal yields being

Victoria	916 half-sieves.
Czars	630 half-sieves.
Myrobolans	236 half-sieves.

Of these 11½ tons or about 40 per cent. were marketed under the National Mark.

The crop from Kiln Field was some 10 tons, the principal yields being

Czars	526 half-sieves.
Monarch	234 half-sieves.

Victorias on this plot were extremely light.

The quality of the fruit was very good, 8 tons, or 80 per cent., being marketed under the National Mark.

From 2s. 6d. to 8s. per half-sieve was obtained for Early Rivers, but, with the heavy Czar crop, glut conditions soon prevailed, only the best samples fetching any appreciable price. From 1s. 6d. to 2s. 6d. per 12 lb. chip was obtained for large National Mark Czars, lower grades only fetching from 1s. 6d. to 2s. per half-sieve. Unfortunately the young Czar plantations on Egham and Church Fields were badly affected by the drought, and in spite of heavy thinning, only produced fruit of the second category. On the other hand the fruit from Kiln Field, where thinning had also been done, consisted mainly of large size selected fruit.

Purple Egg averaged 2s. per half-sieve and Pershore Egg rather under that figure. Victorias did somewhat better averaging 3s. 9d. per half-sieve, prices ranging from 3s. per 12 lb. chip for large National Mark fruit down to 1s. 6d. per half-sieve for the smaller

grades. Monarchs averaged 6s. 3d. per half-sieve, partly due to the fact that a portion of the crop was held over in cold store.

The Myrobolans cropped extremely heavily with the result that much of the fruit was very small and an average of only 2d. a lb. was obtained for the crop, this being the first time that it has fallen below 3d.

Warwickshire Drooper cropped on the light side but good prices were again obtained, fruit marketed from the tree fetching in the main from 2s. 6d. to 4s. per 12 lb. chip with a few down to 2s.

The Presidents after last year's heavy yield were an extremely light crop.

Gross receipts from Kiln Field amounted to £206 or 4s. 5d. per half-sieve, and from the remainder of the farm £496 or 3s. 7d. per half-sieve. If 1s. 6d. is taken as the average cost of picking and marketing 24 lbs. of fruit this represents a net return of 2s. 11d. and 2s. per half-sieve respectively. Somewhat over two-thirds of the crop was marketed in 12 lb. chips and the remainder in half-sieves.

It had been expected that the cold store would have been ready in time to hold over a portion of the Victoria crop, but this was unfortunately not the case. It was, however, possible to store a few chips of Warwickshire Drooper, President, Monarch, and some of the Damsons. The result was well worth while and illustrates the possibilities in the cold storage of plums. By holding over the fruit for a fortnight to three weeks, under by no means ideal conditions, an extra 1s. to 3s. per 12 lb. chip was obtained, Warwickshire Drooper, Monarch and President fetching as high as 6s. per chip. The advance in price far more than covered any wastage involved.

Pears.—(Area under cultivation—5¾ acres in Egham and ½ acre in Church Field, 4 of which consist of a number of different varieties from eight to fifteen years of age. The other 2¼ acres are not yet in bearing.)

Pears gave by far the largest yield of any year since planting, Conference, Fertility, Souvenir du Congrès, Durondeau, Beurré Clairgeau, Marie Louise and Hessle all giving very fair to heavy crops, it being found necessary to thin Hessle and Fertility drastically and Clairgeau to a lesser degree. Emile d'Heyst, Dr. Jules, Beurré Hardy, Comice and Pitmaston on the other hand were on the light side. In all some 930 bushels were marketed, 250 of which were Conference. Of these 370 bushels were marketed under the National Mark Scheme.

Whilst prices did not rule high they were on the whole satisfactory, an average return of 6s. 10d. a bushel being made. That prices were as good as they were was partly due to the fact that the erection of the cold store chambers enabled a proportion of the crop to be held over for a time until the market improved. It was not possible, however, to do so for long owing to the stores being required for the Bramley crop. "Fancy" grade Conference 2½ to 2¾ ins. size made 4s. 6d. to 5s., 2¼ to 2½ ins. 4s. 6d. and 2 to 2¼ ins. 4s. per half-sieve throughout, whilst Domestic grade 2¼ to 2½ ins. made 3s. 6d. to 4s., and 2 to 2¼ ins. 3s. to 3s. 6d. Similar and in some cases higher prices were obtained for Durondeau, Marie Louise, Beurré Hardy, Beurré Clairgeau and Emile d'Heyst. These were all marketed during the last fortnight in October. Total receipts amounted to £320.

Apples.—(Area under cultivation—24 acres in Great East, Egham and Church Fields, consisting of many different varieties and varying ages ranging from four to twenty-one years old. Also a further 14 acres in Kiln Field.)

There were heavy crops of nearly all varieties of apples, the total quantity of marketable fruit, apart from Kiln Field, amounting to some 6,700 bushels, an increase of 1,800 over the previous year. The principal yields were as follows :

Bramley's Seedling	2,250	bushels.
Lane's Prince Albert	1,520	,,
Worcester Pearmain	480	,,
Grenadier	330	,,
Early Victoria	280	,,
Cox's Orange	260	,,

In Kiln Field the total crop came to some 5,000 bushels, the principal yields being :

Bramley's Seedling	2,500	bushels.
Worcester Pearmain	650	,,

The fruit from this plot was generally speaking of very good colour and finish.

In view of the heavy sets thinning was done wherever possible, the fruits of such varieties as Early Victoria and Codlins generally, Beauty of Bath, Gladstones, Miller's Seedling, White Transparent, Grenadier, Lanes and Bramleys in nearly all cases being spaced from 4 to 5 inches apart. Certain other varieties, such as Cox, were thinned to singles. In the case of Early Victorias thinning to 4 inches was often not enough.

With the large quantities of apples on the market, prices have ruled lower than for very many years past. Of dessert apples Beauty of Bath sold well fetching up to 7s. per half-sieve, while Gladstones were difficult to move at all, rarely fetching more than 2s. 6d. National Mark Miller's Seedling sold freely from 3s. 6d. to 5s. per half-sieve. This last, when well grown, is an attractive apple, but generally needs thinning drastically to get the size. Worcesters and James Grieve seldom made more than 4s. per half-box, whilst National Mark Cox before Christmas were selling from 6s. to 8s. Early in January the price had moved up to the neighbourhood of 10s. Some Barnack Beauty wrapped and stored in natural store until the middle of February, did quite well, moving freely at 3s. 6d. to 5s. per half-sieve.

Slow though the trade often was for dessert fruit, cooking apples were a much more difficult market. Grenadiers up to a point sold well, fetching up to 5s. and 6s. a bushel, but Early Victorias unless of really good size were almost unsaleable. Derbys were exceptionally difficult to move, the price for good samples going as low as 3s. and under—in fact up to Christmas it was difficult to get more than 4s. a bushel for any cooking variety.

Fortunately the erection of the gas store chambers previously referred to enabled us to store practically the whole of our crop of Bramleys, Lanes and Edward VII, amounting to some 6,200 bushels. The first chamber was opened in the middle of March, and at the time of writing (first week in April) Lanes are selling up to 9s. a bushel, even the smaller and poorer grades fetching not less than 6s.

Apart from the fruit put into gas store some 3,260 bushels have been sold from the Experimental Farm proper at a gross return of £717, and 2,150 bushels from Kiln Field for £644, or an average return of 5s. a bushel.

Of these, approximately 2,230 bushels have been marketed under the National Mark, and it is estimated that at least another 5,000 bushels from the gas stored fruit will be marketed under that scheme. (A.C.P.)

Hops.

The area under cultivation was 9 acres, comprising 6 acres of Professor Salmon's Seedlings and Commercial Varieties in Egham Field, $2\frac{1}{4}$ acres of Selected Seedlings and $\frac{1}{2}$ acre of Fuggles in Church Field and $\frac{1}{4}$ acre of Commercial Varieties in Upper Grub. About 1 acre was not in full cropping.

Downy Mildew spikes were considerably less numerous than in the previous two seasons, whilst the "terminal spike" form of the disease was almost absent. The gardens were sprayed with Bordeaux mixture on 18th and 19th July and again from 9th to 11th August.

Neither Aphis nor Red Spider was troublesome and only one washing with nicotine and soft soap was necessary against the former.

Our crop was considerably greater than in recent years. The total amounted to nearly 8 tons whereas it was just over 5 tons in the previous season. Part of this increase is due to the fact that various plantings in Church Field are now reaching maturity, though all varieties gave higher yields than in 1933.

Prices ranged from £8 per cwt. for mixed growths to £11 per cwt. for certain seedlings. Ten pockets of L21 fetched £8 10s. per cwt., whilst nine pockets of Fuggles made £8 15s. per cwt. (F.H.B.)

Routine Spraying Programme.

The machine mainly used for spraying was again the 10 h.p. Lister engine driving a three-throw pump, as described in the Annual Report for 1933, page 21.

The method of application was completely altered in principle and practice.* Formerly, 8 ft. lances were used, each carrying a single nozzle which delivered a fairly wide cone of spray with but little "carry" and resistance to wind. The tops and the more remote, inner parts of the trees were reached by manipulation of the 8 ft. lance, but this method always proved fatiguing after spraying for several hours. In the year under review, 4 ft. lances were used, each carrying two nozzles combined (the so-called "double nozzle"), set to deliver a fairly straight, driving spray. The arm-work involved in manipulating these lances was considerably reduced, and was thus less fatiguing. The type of spray had the advantage of width with "carry", and the tops and the more remote, inner parts of the trees were easily sprayed. Timing tests showed that, other things being equal, approximately half the time was taken to spray a tree by the new method as by the old. As twice the volume was delivered from two similar nozzles as from one, the amount of spray used should theoretically be the same by either method. Actually, however, other factors affect the issue with eight men spraying, and, in practice, the proportion does not work out as simply as that. Somewhat more spray was used than formerly, but some of the increase was undoubtedly due to the change-over in technique, and, doubtless, will be modified as the method becomes more familiar to the sprayers.

Coupled with the use of shorter lances was the adoption of a different system of "settings". Eight men worked from one pipe-line. In his "setting", each man sprayed the *nearer* sides of two rows of trees, walking, in the same alley, up one row and back along the other. He then moved into his next alley and did likewise in that. He was thus spraying all the time he was moving, and he avoided the complication of twining his rubber hose around the tree-trunks. Previously, each man walked around the tree he was spraying, and finished that before moving on to the next.

* We are grateful to Mr. J. Turnbull, of the Ministry of Agriculture, for his collaboration.

In setting out the details of the spraying programme below, the general lines of the method adopted in last year's report have been followed. The Research Station reference number of the plots sprayed is given to facilitate comparison of the sprays applied to particular trees, etc., at different periods during the season.

The symbols used for the sprays are :

B.M.	Bordeaux mixture (made with hydrated lime).
L.S.	Lime-sulphur.
A.	Lead arsenate paste.
N.	Nicotine.
S.S.	Soft soap.
S.L.	Sulphite lye (used as spreader).
G.	Spray gelatine.
S.	Sulphur.

All sprays are referred to in quantity of concentrate used *per 100 gallons.*

Routine Spraying Programme, 1934.

Period.	Spray used.	Hosts.	Sprayed against.	Remarks.
		WINTER.		
1st-10th Jan.	Standard **Tar-Distillate** (7½ gals.).	Apples and Plums.	**Aphis, Sucker, Mosses** and **Lichens, Woolly Aphis.**	Kiln Field (about 17 acres). 7½ per cent. spray used as general cleansing wash, for only low pressure had previously been available for spraying this plantation.
10th Jan.	Standard **Tar-Distillate** (6 gals.).	Plums.	**Aphis.**	Plot 21 only. Spraying done in damp weather, so spray used at 6 per cent. to compensate to some extent for moisture on the trees. Weather not good for spraying at this period, but it was considered unwise to leave plums much later.
12th Jan.	Standard **Tar-Distillate** (5 gals.).	Apples, Plums, Cherries, Black and Red Currants, Gooseberries.	**Aphis** and **Sucker** on Apples. **Aphis** on other hosts.	All plots except Plot 21 (plums) and Kiln Field, an established plantation acquired by the Research Station in autumn, 1933 (see above). Pears omitted as in 1933.
2nd-3rd Mar.	**Petroleum Oil** (6 gals.) emulsified with Oleic Acid (as commercial Brown Oleine) (1 gal.) and Caustic Soda (1½ lbs.).	Red Currants.	**Capsid** (*Lygus pabulinus*).	Plots 27, 32, 33, 34. The wash was home-made, according to the method introduced by Mr. Hubert Martin, late of Wye College.
13th Mar.	**L.S.** (3⅓ gals.).	Outdoor trained Peaches.	**Leaf-curl** (*Taphrina deformans*).	At Ditton Lab., on Plot 18 and a few on Plot 17.
		SPRING AND SUMMER.		
13th April et seq.	**L.S.** (5 gals.).	Black Currants (*" grape " stage of flower-truss*).	**Big-Bud Mite.**	Plots N2, N5, C4, C5a, 17, 18, 29, 35. 5 per cent. used throughout instead of 8½ per cent. (as in 1933) because the stronger spray causes damage to varieties in the " Edina " group which are interplanted, and also because the plantations are now very free from the pest.
	L.S. (3⅓ gals.).	Gooseberries (*pre-blossom*).	**Mildew.**	Plot 36 (gooseberries underneath pears).
20th-21st April.	**L.S.** (3⅓ gals.).	Pears (*white-bud*).	**Scab.**	Plots 36, 20. Lead arsenate paste (4 lbs.) included for caterpillar on Plot 20 (no intercrops) but not on Plot 36 because gooseberries underneath were in flower. Lime-sulphur and not Bordeaux used because of possible greater effectiveness of the former in the *early* stages. (See *E. Malling Res. Sta. Ann. Rep.* for 1932, pp. 99-108.)

Period.	Spray used.	Hosts.	Sprayed against.	Remarks.
1st-3rd May.	**L.S.** (3⅜ gals.) + **A.** (3 lbs.).	Apples (*pink-bud*).	**Scab** and **Caterpillar.**	All varieties except Stirling Castle. Plots 2 (variety collection), 8 (cordons), 10, 11, 12, 13, 14, 16, 30, 31, 33, 34, C2, C3. (Young pears on C3 omitted—in full flower.)
2nd May.	**L.S.** (2½ gals.) + **N.** (8 ozs.) + **S.L.** (¾ gal.).	Apples (*pink-bud*).	**Scab** and **Capsid** (*Plesiocoris rugicollis*).	Plots 3 and 4, where patches of capsid damage had been noted. Arsenate omitted in the expectation that nicotine would be effective against young caterpillars. Strength of lime-sulphur reduced from 1-30 because spray washed on.
4th-7th May.	**L.S.** (3⅓ gals.) + **A.** (4 lbs.) **or** **L.S.** (2½ gals.) + **A.** (4 lbs.).	Apples (*pink-bud*).	**Scab** and **Caterpillar.**	Kiln Field. Strength of lime-sulphur reduced on west half for comparison (with east half) of amount of spray-damage. Barnack Beauty and Chas. Ross omitted—blossoms too forward.
15th May.	**B.M.** (8 lbs. bluestone, 12 lbs. hyd. lime) + **N.** (8 ozs.).	Pears (*petal-fall*).	**Scab** and **Aphis.**	Plots 20, 36. Nicotine included because pears not winter-washed.
17th-18th May.	**L.S.** (1 gal.) + **G.** (1 lb.).	Plums (*post-petal-fall*).	**Red Spider.**	Plots 21, 29, C4. Gelatine used for its sticking properties.
25th May.	**N.** (8 ozs.) + **G.** (2 lbs.).	Certain apple varieties (*petal-fall*).	**Capsid** and **Sawfly.**	Kiln Field West (Lane's, Derby and Blenheim only). Unsafe to use lime-sulphur or Bordeaux for Scab.
26th May.	**L.S.** (¾ gal.) + **N.** (8 ozs.) + **S.L.** (¾ gal.).	Apples (*petal-fall*) and Plums (*post-petal-fall*).	**Scab, Sawfly** and **Red Spider.**	Kiln Field East and West. All varieties except trees sprayed on previous day. Lime-sulphur weaker than normal because of fear of injury with heavy spraying.
28th May.	**B.M.** (6 lbs. bluestone, 12 lbs. hyd. lime) + **N.** (8 ozs.) + **S.L.** (¾ gal.).	Apples (*petal-fall*).	**Scab** and **Sawfly.**	Plots 12, 13, 14. Bordeaux used instead of lime-sulphur because severe Scab-infection had developed on the calyx during blossom, and lime-sulphur was expected to damage the trees if used at a strength thought necessary to arrest existing infection. Bordeaux was reduced in strength from normal as precaution against damage, for the spray-application was heavily made for Sawfly-control.
29th May.	**B.M.** (8 lbs. bluestone, 12 lbs. hyd. lime).	Apples (*petal-fall*).	**Scab.**	Plots 4 and 10. Bramley's and Newton. Lime-sulphur not used because of proximity of Lane's. Nicotine not used as Sawfly was absent from these trees.

Period.	Spray used.	Hosts.	Sprayed against.	Remarks.
29th May.	**L.S.** (1 gal.).	Apples (*petal-fall*).	**Scab.**	Plots 3 and 4. Only certain varieties, the others being used in spraying experiments. Nicotine omitted for this reason.
29th-31st May.	**L.S.** (¾ gal.) + **N.** (8 ozs.) + **S.L.** (¾ gal.).	Apples (*petal-fall*).	**Scab** and **Sawfly.**	Plots 8 (cordons), 16, 30, 31, 33, 34, 35, C2. Lane's and Belle de Boskoop omitted.
30th May.	**B.M.** (8 lbs. bluestone, 12 lbs. hyd. lime).	Apples and Pears.	**Scab.**	Plot C3. Lane's omitted. Sawfly absent, so nicotine not used.
31st May.	**L.S.** (1 gal.).	Plums.	**Red Spider.**	Plots N1, N2, N3, N4.
4th June.	Proprietary **White-oil** (2 gals.) + **N.** (8 ozs.) + **G.** (1 lb.).	Apples.	**Red Spider.**	Plot 30. (Belle de Boskoop.)
4th June.	**B.M.** (8 lbs. bluestone, 12 lbs. hyd. lime).	Apples.	**Scab.**	Kiln Field East (Bramley's). Scab getting the upper hand on these Bramley's.
5th June.	Proprietary **White-oil** (2 gals.) + **G.** (1 lb.).	Apples.	**Red Spider.**	Kiln Field West. (Lane's, Derby and Blenheim only.)
5th-7th June.	**B.M.** (8 lbs. bluestone, 12 lbs. hyd. lime).	Pears (*second-post-blossom*).	**Scab.**	Plots 20 and 36. Conference omitted because resistant to Scab.
5th June.	**L.S.** (1 gal.) + **G.** (1 lb.).	Plums (*second-post-blossom*).	**Red Spider.**	Plots 21 and 29. Gelatine used for its sticking properties.
7th June.	Proprietary **White-oil** (2 gals.) + **G.** (1 lb.).	Apples.	**Red Spider.**	Plots 3 and 4. Certain infested varieties only.
8th June.	Proprietary **White-oil** (2 gals.) + **N.** (8 ozs.) + **G.** (1 lb.).	Apples.	**Red Spider.**	Plots 11, 16 and C3. (Lane's and Grenadier.)
8th June.	**L.S.** (¾ gal.) + **N.** (8 ozs.) + **S.L.** (¾ gal.).	Plums and Apples.	**Red Spider** and **Aphis.**	Plot 2. (Variety collection.)
9th June.	Proprietary **White-oil** (2 gals.) + **N.** (8 ozs.) + **G.** (1 lb.).	Damsons.	**Red Spider** and **Aphis.**	Plot C4 (headlands).
9th June.	Proprietary **White-oil** (2 gals.) + **G.** (1 lb.).	Apples.	**Red Spider.**	Plot 32. (Stirling Castle and unsprayed Cox's in spraying trial.)
9th June.	**B.M.** (8 lbs. bluestone, 36 lbs. hyd. lime).	Walnuts.	**Walnut Bacterial Blight** (*Pseudomonas Juglandis*).	Plot 24. (Nursery trees.)

Period.	Spray used.	Hosts.	Sprayed against.	Remarks.
26th June.	Proprietary Derris powder (2 lbs.) + S.S. (5 lbs.).	Raspberries.	Beetle (*Byturus tomentosus*).	Plot N1 (main crop), 28, 29 (odd lots).
26th-27th June.	N. (6 ozs.) + S.S. (4 lbs.).	Hops.	Aphis (*Phorodon humuli*).	Plots C5, 26, 27.
2nd July.	L.S. (1 gal.) + G. (1 lb.).	Apples and Plums (*second post-blossom*).	Scab and Red Spider.	Plots 3, 4, 12, 13, 14, 16, C3 (including pears), Kiln Field East and West. Newton, Lane's and Rival omitted.
4th July.	L.S. (¾ gal.) + N. (6 ozs.) + G. (1 lb.).	Young Apples (*second post-blossom*).	Scab and Aphis.	Plot C2.
16th July.	N. (6 ozs.) + S.S. (5 lbs.).	Young Apples.	Aphis.	Plot C2. (Only on those trees where necessary. Application by knapsack.)
18th-20th July.	B.M. (10 lbs. bluestone, 15 lbs. hyd. lime) + N. (5 ozs.).	Hops (just *pre-burr*).	Downy Mildew (*Pseudoperonospora Humuli*) and Aphis.	Plots C5, 26, 27 and N5. First spray (usually applied when Hops have reached top wire) omitted this year on account of very dry weather.
23rd-26th July.	N. (6 ozs.) + S.S. (6 lbs.).	Apples.	Woolly Aphis.	Kiln Field West.
26th & 27th July.	N. (6 ozs.) + S.S. (6 lbs.).	Young Apples.	Aphis.	Plots C2, 15, 17, 18. Application by knapsack.
26th July.	B.M. (8 lbs. bluestone, 36 lbs. hyd. lime).	Walnuts.	Walnut Bacterial Blight.	Plot 24 and headland trees elsewhere.
30th July.	Flowers of S.	Hops.	"Red Mould" (*Sphaerotheca Humuli*).	Plots C5, 26, 27. About 2¼ cwt. dust used on nine acres.
9th & 10th Aug.	B.M. (10 lbs. bluestone, 15 lbs. hyd. lime) + N. (6 ozs.).	Hops.	Downy Mildew and Aphis.	Plots C5, 26, 27, 30a, N5.
21st Aug.	Flowers of S.	Hops.	"Red Mould."	Plots C5, 26, 27.

Severe russeting occurred on Bramley fruits on Plots 12, 13 and 14, sprayed at petal-fall with Bordeaux mixture (6 : 12 : 100), Nicotine (8 ozs. per 100 gals.) and Sulphite Lye (0·75 per cent.). This mixture also caused excessive frothing on agitation, so much so that the machine was submerged in it. It is difficult to find a satisfactory explanation for the russeting, for the Bordeaux was weaker than normal. It is possible that heavy spraying with a spray containing a wetter was the cause, or it may be that the Bordeaux caused damage by being applied after lime-sulphur, used at pink-bud.

The varying concentrations of lime-sulphur and of lead arsenate used on apples at pink-bud have their origin in an attempt to mitigate spray-damage, which was thought to be due to somewhat heavier spraying referred to in a description of new technique of application (above). Similar damage (leaf-burn) was reported from many sources this year, however, and it is uncertain whether the leaf-condition was in some measure responsible (see this Report, page 210).

(M.H.M.)

Section II

GENERAL REVIEW OF RESEARCH WORK WITH SUMMARIES OF PAPERS PUBLISHED DURING THE YEAR

POMOLOGY

In Relation to Tree Fruits

(*a*) ROOTSTOCK INVESTIGATIONS.

APPLES.

The past year has seen heavy crops of apples on the main rootstock experiments on Lane's Prince Albert and Bramley's Seedling, which have now completed their fifteenth season.

With regard to the former variety, trees on rootstocks of intermediate vigour show a slight falling off in crop compared with 1933, their maximum cropping year to date ; and this cannot wholly be ascribed to the fact that fruit on most of the trees was now thinned for the first time. On the other hand, trees on the most vigorous rootstocks do not appear to have achieved their maximum cropping capacity as yet, the crops still increasing annually. In this respect, trees on No. XII are still behind those on the slightly less vigorous No. XVI.

Bramley's Seedling has shown a marked biennial tendency during the last four seasons and this year all trees had their maximum crop so far—the larger trees on Nos. II, XVI and XII bearing between nine and ten bushels per tree. It may be noted, moreover, that the earlier cropping trees on such stocks as Nos. VII and IV, which since their ninth year have even in an " off " season produced not less than two bushels of fruit, show as yet no signs of deterioration ; and those on No. IV actually averaged ten bushels per tree—their heaviest crop to date.

Cox's Orange Pippin in its thirteenth season also produced its heaviest crop on all rootstocks ; but here the story is naturally not so far advanced as on the older trials. Trees on the vigorous stocks such as No. XVI show no signs of cropping to capacity as yet, and those on the intermediate stocks are still well ahead.

The Worcester Pearmain stock trial showed signs this season of having suffered from overcrowding by the adjacent Bramley's Seedling and all these trees showed a slight falling off in crop.

It will be remembered that two years ago on a nearby plot the Worcester Pearmains were removed to give latitude for the Bramley's Seedling—the two varieties being originally interplanted at fifteen feet square. This Winter, grassing down four years ago having failed to solve the problem, it has become necessary to thin two more plots. In

the one case the Bramley's Seedling have had to be removed, and these have been replaced by Worcester Pearmain from the old "Starvation acre", giving a composite plot of Worcester Pearmain. In this plot a small proportion of Cox's Orange Pippin will be planted for pollination. These trees will afford interesting information concerning the recovery of trees at this age after transplanting.

A full report on the apple rootstock investigations is in preparation.

The lifting of these two series of trees gave a further invaluable opportunity for root observation. Descriptions of the roots of the Bramley's Seedling confirmed unmistakably the findings of two years ago on Worcester Pearmain.

Once more the root characters of the different varieties of rootstock were clearly marked, although naturally the root systems as a whole were considerably larger under this more vigorous variety.

As was suspected, scion rooting was of more frequent occurrence especially on the dwarfing stocks. Seven out of eight on No. IX had large scion roots, the original root system being generally subsidiary and often showing signs of dying out. The effect of this rooting was clearly seen in tree vigour. All the three trees on No. VIII were scion rooted. Two out of eight trees on No. II and one on No. VII showed roots from the scion but these were all of recent origin and were apparently not yet sufficiently developed to have had any influence on the size of these already vigorous trees.

(R.G.H., T.N.H. and J.A.)

A complex trial of Cox and Worcester single cordons on rootstocks Nos. I, II, IV, VII, IX and XII has been planted. The treatments include two distances of planting, viz. (*a*) 1 ft. 9 ins., (*b*) 3 ft. 6 ins. apart in the rows, and two methods of pruning, viz. (*a*) Summer, (*b*) Winter + Summer pruning. The trial is planned so that two manurial or other remedial measures can be superimposed later as occasion arises.

(A.B.B.)

Analysis of Rootstock Influence, including the Reciprocal Effect of Scion on Root.

The series of Lane's Prince Albert trees, "stem worked" and "root worked" on vegetatively raised rootstocks and upon seedling roots have now been three seasons *in situ*, having been planted as two-year-olds in January, 1932. Up to the present the relative vigour and amount of fruit bud formation of trees on Nos. IX, II and XII repeat the performance of the earlier series of stem worked trees and there is no evidence to show that the elimination of the stem piece has altered this in any way. The trees on seedling rootstocks are on the average somewhat less vigorous than those on No. XII, but at present they are not more variable in size. In fruit bud formation they appear more variable than on No. XII, which has uniformly produced very few fruit buds. While on the average the trees on seedlings have had rather more blossom than those on No. XII, in no case do they equal the performance of trees on Nos. II and IX in this respect.

Counts of fruits set confirm these results. (R.G.H. and J.A.)

The figures obtained from the microscopic study of sections of roots and stock stems of bench grafted Lane's Prince Albert apple trees on Nos. IX, II, XII, and seedlings have now been examined. In addition to the differences in structure between roots and stems above and below ground, considerable differences in anatomical structure peculiarly associated with the rootstock have been shown to exist, especially with regard to vessel

size and numbers of xylem fibres per unit area. In order to investigate this matter further, a preliminary examination of the internal structure of unworked rootstocks Nos. I, II, VII, VIII, IX, XII, XIII and XVI has been carried out by means of a projection apparatus. The results have not yet been fully examined. A complete range of unworked rootstocks has been planted for sectioning work.

A series of sections of roots of thirteen year old Worcester trees on rootstocks Nos. IX, II and XII were examined and were found to differ somewhat from roots of comparable size of the same rootstocks grafted with Lane's Prince Albert. The Lane's trees were, however, much younger. In order to obtain some more reliable information about possible scion influence, three sets of trees on rootstocks Nos. IX, II and XII have been worked with Lane's Prince Albert, Bramley's Seedling and Grenadier as scions.

A.B.B.

PEARS.

In the Autumn the results of twenty years' investigations upon rootstocks for pears were reviewed (E66). The methods of classifying, identifying and standardizing (by vegetative propagation) Quince and Free Pear stocks were summarized ; and the phenomenon of incompatibility of certain Quince and Pear stocks in the nursery was recalled.

A comparison was made of the vigour and cropping of ten-year-old trees of Dr. Jules Guyot on five selected Free Pear stocks. Similar characteristics of three varieties on Quince and Seedling pear stocks were compared and the growth characters peculiar to trees on Pear and Quince described. Individual trees on Seedling stocks were shown to have cropped quickly and it was suggested that desirable Free stocks might be selected and standardized.

The vigour and cropping of seven varieties—from ten to fourteen years old—on various Quince stocks were detailed. The general utility of Quince A and B were compared ; it was shown that after nine years nearly all trees on Quince C fell behind in vigour, owing to the superior cropping on that stock ; but Quince D was shown to be a most undesirable variety.

The phenomenon of scion rooting, especially of trees on Quince, was described and shown to be of common occurrence. The detrimental effect on cropping was illustrated. (R.G.H. and J.A.)

PLUMS.

Records of size and cropping of a considerable range of varieties on clonal rootstocks are being continued ; and it is hoped to present a report in the near future.

Comparisons of ungrafted plum trees on their own roots with those on different rootstocks are now yielding interesting information. As in the case of apples, it is not possible to lay down hard and fast rules for their performance. Compared with such standard rootstocks as Myrobolan B. and Common Mussel, some varieties on their own roots are found to be as vigorous as trees on Myrobolan, while others approximate more nearly to trees on the latter more dwarfing rootstock.

Similarly with cropping, while practically all varieties on their own roots have cropped at least as well as trees on Mussel, in several cases, notably Victoria, Pershore Egg and Warwickshire Drooper, the yield has been considerably higher ; and this is not entirely due to superior vigour. (R.G.H. and J.A.)

PEACHES.

The trained trees of Hale's Early planted against a board fence set a moderate crop which was successfully harvested.

The clonal races of common peach raised by layering will be included in nursery trials as opportunity offers. (R.J.G.)

CHERRIES.

(i) *Sweet Cherry scions.*—The available number of acid cherry stocks is increasing and it is hoped will be large enough at the end of 1935 for a trial of sweet cherry scions on Mazzard and acid cherry stocks. (N.H.G.)

PROPAGATION.

The testing of new rootstocks of apple, pear, plum and cherry for ease of propagation by vegetative means continues. Further nursery trials will be planted, as these stocks become available, to test compatibility with commercial scion varieties and to obtain preliminary records of stock effect as shown in new wood growth and fruit bud formation. The nursery testing of new apple rootstocks, immune to Woolly Aphis, has been continued in collaboration with the Plant Breeding and Entomology sections.

Signs of incompatibility are apparent amongst a very few of the seedling Prunus which originated in the Caucasus and were budded with Czar in 1931.

The two-year-old apple trees composed of three varieties of " stem-builders " obtained from Germany and budded at three inches above ground-level on the rootstocks Nos. IX, XII and a race of seedlings, have been grafted at five feet above the union with commercial varieties. Records of wood growth and fruit bud formation will be taken, in order to measure the effect of a long piece of intermediate on the stock-scion relationship.

Two further series of apple trees have been frameworked in various ways and the methods used in 1933 were described (Eg7). Further trials will be undertaken in the Spring of 1935 with special reference to the occurrence of disease in certain apple varieties following top-grafting. The preparation of a series of plum trees having disease resistant frameworks has been continued in collaboration with the Mycology section and the heads of the trees are now ready to receive grafts of a susceptible variety.

Investigations into the technique of the propagation of rootstocks by means of layering and by hard- and soft-wood cuttings and root-cuttings have been continued in collaboration with the Physiology section.

The nursery technique studies continue and a series of confirmatory trials have been laid down and, in the trials of the effect of the presence or absence of wood in the bud shield, have been extended from apples to pears, plums and cherries. Three differing types of rubber strip have been tested with a view to obtaining a suitable material for tying inserted buds.

Some thirty varieties of flowering cherries have been budded on to selected vegetatively propagated Mazzards (*P. avium*). Probable incompatibilities have appeared in the first season. Rootstocks such as are commonly used in Japan are being raised and will be budded with these varieties when available in sufficient quantity. (R.J.G.)

(*b*) ROOT DEVELOPMENT INVESTIGATIONS.

Direct observations on growing apple roots have been continued at weekly intervals by means of our " observation trenches " in the orchard. These trenches have glass

windows fixed against the soil, and protected from light. The technique and preliminary results have been described in a progress report (E73). The roots of mature trees on two different rootstocks have now been under observation at East Malling for three years, and a third rootstock for four years. It is now possible to note the manner in which the fine absorbing rootlets spread in successive waves, "combing" the soil through and through. On account of the suberizing, shrinkage and, in the case of many of the finest roots, death and rotting away of the roots, the soil is left permeated by fine channels which must be of considerable importance in the drainage and aeration of the soil. The data are now being prepared for a full report. Records of soil temperature and moisture have been obtained, and confirm previous findings as to the direct relationship between soil warmth and root growth, with sufficient moisture as a limiting factor.

In the latest type of observation trench, special arrangements have been made for the application of local treatments to selected roots. Lack of time has prevented full use of these devices at present, and for the same reason the projected study of the effect of grass roots on apple root growth has been postponed.

A repetition of the trial (in root observation boxes) of effect of light on root growth has confirmed that a weekly exposure of thirty minutes is sufficient to cause a definite check to the root. Hence it is clearly desirable to keep the time of recording as brief as possible.

Some strawberry plants have been grown in root observation boxes, and it has been found possible to make observations on the root growth. The technique is not so easy as it is for apples, however, on account of the very numerous and fine roots of the strawberry plants. A preliminary trial of the development of "Root Rot" on these observation boxes is being carried out in collaboration with the Pathology section.

(W.S.R.)

Soil Moisture Recorders.

As a result of the great interest shown in the direct reading soil moisture recording instruments which we have developed in connection with the above work, arrangements have been made for their manufacture and marketing by a firm of instrument makers (Messrs. A. Gallenkamp & Co. Ltd., 17-29 Sun Street, London, E.C.2). Considerable improvements in design have been obtained as the result of further study, but at present these instruments are only suitable for permanent use on sandy and loamy soils. The working of these instruments was briefly described in the publication mentioned above (E73), and a fuller report is in the press. (W.S.R.)

Tree Excavations.

A study of the root systems of a comparable series of mature apple trees on the main types of rootstock on sand, loam and clay soils has been fully reported (E75). The root system of a ten-year-old Lane's Prince Albert apple tree on rootstock No. II excavated from a heavy clay soil has been reconstructed as a permanent exhibit in the gallery of the new grading shed. (W.S.R.)

(*c*) INVESTIGATIONS IN BIENNIAL BEARING.

Whilst there is evidence to show that with a markedly biennial bearing variety like Early Victoria, the year of bearing can be altered by removing the blossom, negative results have been obtained with certain other varieties, such as Lane's Prince Albert,

where biennial bearing was not much in evidence, and even with Newton Wonder, where it was.

The investigations will be continued as opportunity offers.

(N.H.G. and A.C.P.)

(*d*) DOUBLE WORKING OF FRUIT TREES.

There are no further developments in this work at present. A report has for some time been in preparation. (N.H.G.)

(*e*) INVESTIGATIONS INTO THE NON-SETTING OF THE BLOSSOM OF CERTAIN VARIETIES OF PEARS.

Observations were continued on the dehorned and top-grafted trees of Doyenne du Comice and on the spur thinned trees of Marie Louise. A series of maiden trees consisting of Doyenne du Comice single worked, worked on itself, and on Glou Morceau, all on Quince A, were planted out and are being trained in single U form, the first and second scion—where present—each forming one branch of the U. The object of this trial is primarily to test the empirical theory of " sap transfusion " from the intermediate to the second scion in its effect on blossom setting.

(N.H.G., N.B.B. and H.M.T.)

(*f*) PRUNING.

APPLES.

The least valuable of these trees have now been discarded, and weights of head, stem and root recorded. There are no other fresh developments at present. (N.H.G.)

PEARS.

Experimental pruning treatments on the older series of pears which are now thirteen years old are being continued, heavy crops of fruit being harvested in 1934.

Differential methods of pruning the leaders of the nine varieties in the younger pruning trial, now five years old, have been commenced. The relative effects of hard and light leader tipping are being compared, firstly where a large number of leaders have been left and secondly where the number of leading shoots has been restricted.

The treatments of the laterals is being adapted to the needs of each variety, the methods being based on the experience gained in the older experiment.

(J.A.)

CHERRIES.

The " dehorning " of alternate Morello trees has yielded encouraging results; growth following the hard cutting was excellent, and of four or five trees infected by *Stereum* all recovered except one. Cropping was not so long delayed as was expected. The remaining trees in the plot will probably be dehorned at the end of 1935.

(N.H.G.)

(*g*) FRUIT THINNING.

APPLES.

The experiments previously referred to are now being brought to a close, with the possible exception of that on the dessert varieties which may be continued in a modified form. A report will be issued in due course. (A.C.P.)

(*h*) MANURING.

The experiments in the restoration of unmanured trees to good health and the combined use of grassing and manuring to obtain a suitable balance in the tree have been continued (E72).

Though the effect of applications of potash and nitrogen to previously unmanured apple trees had been clearly shown in growth and health of foliage, manuring was continued for one more year in order to include another full crop in the period of the experiment, and so complete the records on this aspect of the tree's response. With Bramley's Seedling, where colour is not required, a combination of potash and nitrogen gave better results than potash or nitrogen alone. With Worcester Pearmain, however, colour is of great importance, and potash alone gave the best results in that respect. Potash and nitrogen together gave slightly less colour than nitrogen alone, an effect probably due to the greater density of the foliage. For the first time symptoms of nitrogen deficiency became apparent and were most marked on the trees receiving potash only.

The plot of Bramley's Seedling under grass showed, even more markedly than in the previous year, the effect of a dressing of 5 cwt. per acre of nitro-chalk on foliage, growth and colour of fruit. The primary effect of the grass was apparently to reduce spur foliage and growth of laterals, that of the leading shoots being less affected.

In the experiment in which Worcester Pearmain under grass had received 5 and 15 cwt. of nitro-chalk per acre in the previous year there was a carry-over of the effect of the heavy dressing. Though the trees which had received 15 cwt. in 1933 were given nothing in 1934 the fruit from those receiving 5 cwt. each year was again in most cases larger and had more and brighter colour, while with most stocks the 15 cwt. trees made more growth and bore denser and larger foliage.

In the trial designed to show the effect of nitrogen, potash and phosphate, alone and in combination, the young trees of Cox's Orange Pippin and Beauty of Bath have continued to show the marked effect of potash on growth and foliage. The Cox's bore their first crop of any size and a flavour test showed that while potash alone was beneficial and nitrogen alone detrimental, both were beneficial when used in combination. With Beauty of Bath, the most marked effect was the delay in ripening where potash was given, possibly indirectly due to the denser foliage. The varying response of trees on different rootstocks to the same manurial treatment, already shown in their growth, was seen also in fruit quality.

The preliminary trial of application of nitrogen to young apple trees at five different times of year has not yet shown any striking differences. (W.A.B. and T.N.H.)

Plums.

The pot culture experiment with the variety Victoria has been continued in collaboration with the Pathology Section. Stem inoculations have been made this Autumn.

(F.H.B. and H.W.)

(*i*) VARIETY COLLECTIONS AND TRIALS.

Apples.

Records have been continued on cordon apples and pears. Some new varieties have been added to the collection. (H.C.C.)

(*j*) FRUIT BREEDING.

Rootstocks.

The work of raising new varieties of apple rootstock combining the qualities associated with good rootstocks with immunity to Woolly Aphis, undertaken jointly by the John Innes Horticultural Institution and this Station, has consisted largely in the crossing together of pairs of immune varieties, certain lesser known immune varieties from the Dominions having been used here for the first time this season. The back crossing and intercrossing of selected immune seedlings has been continued.

Three immune seedlings selected from a family of Spy × II have been subjected to a small initial trial, worked with Lane's Prince Albert, since 1930 and a preliminary report giving details to date of the vigour and fruitfulness of these trees was published (E70). The three seedlings were then very similar in their influence on the scion both as to vigour and fruitfulness. Compared with trees on the dwarfing No. IX they made rather more than twice as much wood growth and produced less than half as many blossom buds during their third year. More comprehensive trials, including a fourth immune seedling are now in their first and second years respectively. A progress report bringing the results of these trials up to date is published in another section of this Report.

Several further families of seedlings have been raised from crosses between members of the " Paradise " rootstocks. Observations have been continued upon a number of families from crosses between No. IX and other members of this series and a paper dealing in detail with observations on leaf shape and leaf petiole length has been prepared for publication. About forty of these seedlings have now been selected as worthy of further trial as rootstocks. With the object of gaining information as to the inheritance of rootstock influence in seedlings of known parentage, two families comprising approximately 180 seedlings have been planted out in their entirety and worked with Lane's Prince Albert.

The initial trial containing nine selections from a family VIII × IX worked with Lane's Prince Albert in 1930 has been carefully studied and a progress report dealing with these trees has been published (E70). Trees on these selections showed very wide variations in wood growth throughout and, by their third year, trees on the least vigorous of them had made considerably less wood growth than comparable trees on No. IX while trees on the most vigorous had made almost three times as much wood growth as those on No. IX. Trees on all the selections, however, were blossoming heavily by their third year, those on seven of the nine selections bearing more blossoms, on the average, than the trees worked on No. IX. Further, more comprehensive trials of these new seedlings are now in their first and second year.

A large number of " wilding " apple, pear and quince, raised from seed collected in the Caucasus and Turkestan are being tested as possible new rootstocks which may possess exceptional hardiness, disease resistance, etc. A number of pear seedlings from other sources are also being tested for ease of vegetative propagation.

In an attempt to combine ease of propagation by vegetative means with a wider range of influence over the scion, about 150 seedlings raised from crosses between several of the most widely used plum rootstocks are ready to be planted out. A preliminary report on young Czar plums worked on selected seedlings of *Prunus divaricata*, dealing with their vigour and compatibility was published (E71). Cases of incompatibility with Czar were comparatively rare. Wide variations in vigour at one year old occurred between trees on the different selections, trees on the most vigorous having produced more than three times as much wood growth as trees on the least vigorous.

Scion Varieties and Shortening the " Juvenile Period ".

Further families of apple and pear seedlings have been raised with the object of obtaining new varieties bearing fruits of high quality, good flavour or extended season. Fresh crosses have been made in the hope of obtaining information on the inheritance of fruit colour in the apple. A number of crosses were made between varieties of the apple immune to Woolly Aphis and varieties of high commercial value in an endeavour to produce new varieties of apple of high quality immune to Woolly Aphis. These seedlings are being subjected to artificial inoculation tests by the Entomological Section.

A number of methods for hastening the fruiting of seedling apples are being investigated, including working upon precocious rootstocks, pruning, top-grafting upon mature trees and growing in pots. About ten trees in a batch of apple seedlings, raised in 1929, growing on their own roots and worked on rootstocks Nos. IX and XII blossomed and fruited for the first time during the past year. All ten trees which fruited were worked upon No. IX. This confirms the indication, already reported in 1928, of the value of a dwarfing and precocious rootstock for bringing seedling apples into blossoming and fruiting. The fruit from several of these trees possessed promising characteristics.

In a combined attempt to elucidate the causes of the unsatisfactory sets of fruit obtained on Doyenne du Comice pear, the blossom of trees on three types of quince, lightly and severely dehorned and overworked with Glou Morceau were once again pollinated with Glou Morceau and Conference. Little success in setting fruit was obtained with either in any of the series. (H.M.T.)

(*k*) POMOLOGICAL ASPECTS OF SPRAYING.

As opportunity offers, data are being collected on the effect of factors such as rootstock, manurial treatment, cropping and weather conditions on the incidence of spray-damage. [See *Pomology* (*h*).]

A field trial, started in 1933 to test the possibility of reducing lime-sulphur injury by the use of ferrous sulphate in the spray, was continued in 1934 (see Mycology and Bacteriology " Spray-Injury Trial "). (M.H.M.)

(*l*) MARKETING PROBLEMS.

The influence of such factors as variety, stock, pruning, thinning, cultural and manurial conditions, as heretofore, is being carefully watched in relation to market value over a period of years. (A.C.P.)

(*m*) ARTIFICIAL IRRIGATION OF APPLE TREES.

The dry Summer provided an opportunity for a repetition of an apple tree irrigation trial, similar to that carried out in 1932. The varieties Early Victoria and James Grieve were used. Water, equivalent to 9 ins. of rain, was applied by the furrow method to a row of sixteen trees in mid-June. This amount of water penetrated to a depth of 30 ins. The average size of fruit was slightly larger on the irrigated trees than on the unirrigated controls. A storage experiment was carried out with the James Grieve fruits to determine whether the irrigated apples were more liable to bitter pit than non-irrigated apples. The storage properties of both lots of fruit proved to be excellent, and no difference was found between them.

Moisture meters were installed at two depths in the irrigated and control rows, and have given some very interesting information concerning the spread of irrigation water and rain water, and the drying of the soil by the trees and by evaporation.

(W.S.R.)

(*n*) WALNUT WORK.

The grant from the Ministry of Agriculture for this work ceased in 1933 and work is only being continued as material assistance allows. (J.B.M. and A.W.W.)

(*o*) KENT FRUIT SOILS SURVEY.

The joint report on the survey of the Lower Greensand in Kent has been published by the Ministry of Agriculture (Bulletin No. 80). The report on the Hastings Beds survey is in course of preparation.

Trees are being raised for the planting of small plots on certain soil series in the Winter of 1935-6. These will give a greater measure of the potentialities of trees on various rootstocks than could be obtained from the material found during the survey. In addition, a simple manurial issue will be included. (W.A.B.)

In relation to Small Fruits

(*a*) NOMENCLATURE, CLASSIFICATION AND VARIETY TRIALS.

Black Currants.

Crop records are being continued on the older series of black currants, in which are included representatives of the four main groups, in order to maintain the continuity of those records until the new trial planted on Newgates Field a year ago comes into cropping.

The trial of Baldwin and Wellington's Triple X at different distances, planted in 1932, bore its first crop this season. Partly owing to the closer planting of this variety Baldwin had a considerably higher acreage yield this year. Nevertheless the crop per bush of Triple X in this season was actually lower than that of Baldwin.

(R.G.H. and J.A.)

Red Currants.

With the exception of one variety, La Constante, which bore about 1 lb. per bush in 1933, the trial of clonal races of principal varieties of classified red currants bore its first considerable crop in 1934. Very marked differences in amount of fruit were observed, the fourteen varieties dividing up in to four broad groups.

The crops are, however, still small—at the most a little over a ton per acre—and do not at present give a reliable index of the true value of the varieties, some of the heavier cropping varieties being of little commercial value owing to the poor size of the fruit. (R.G.H. and J.A.)

Blackberries and Loganberries.

Records are being continued on the blackberry and dewberry collection.

A small collection of " loganberries " from various sources with distinctive leaf or other characters has been planted. The different types will be carefully recorded and clones raised of any which give a particularly good performance.

(A.B.B.)

(*b*) PROPAGATION AND THE ESTABLISHMENT OF CLONAL RACES.

The clonal stool beds of blackberries, dewberries and loganberries have yielded a good supply of plants, some of which will be used for new trials and some for extending the stool beds. (A.B.B.)

STRAWBERRIES.

(i) *The establishment of virus-free clones.*

Our virus-free clonal race of Royal Sovereign has now reached sufficient numbers for large-scale propagation. Two large runner beds have been planted in an isolated position on the Research Station, and three " daughter nurseries " at selected centres in Kent and Sussex (see Pathology, " Yellow-edge Virus " work). A virus-free clone of Tardive de Leopold now numbers about 1,000 plants. Clones of various other commercial varieties (including Paxton, Huxley, Madame Lefebvre and Stirling Castle) and of several recommended strains of Royal Sovereign are being raised. When a sufficient number of plants is available, a new " clonal strain " trial will be carried out, possibly combined with a variety trial. (W.S.R.)

(ii) *Individual plant studies of clonal families.*

The tracing out of the life history of all the plants of six clonal families (of three strains) has been continued. Individual plant records of vigour, health and cropping have been obtained on these plants (which number some 800), from the time of their formation onwards. Their third crop will be borne in 1935.

Similar individual plant records (including crop) have been obtained on a second " generation " of this trial, numbering some 1,200 plants. The object of these trials is to trace out the effect of time of origin, position on stolon, health and vigour of parent, etc. on the subsequent performance of the plants. Results to date seem to justify the conclusion that *once it is established,* every healthy runner has an equal chance. The small late formed runners are, however, more liable to damage by adverse conditions following planting, and are more severely checked by the " warm water treatment " than are the larger runners. (W.S.R. and J.L.E.)

(iii) *Uniformity trials.*

The second trial has been planned as a " Uniformity Trial " in collaboration with the Statistical Section, to obtain information on the ideal size and shape of plot. (J.L.E.)

(iv) *Runner bed arrangement.*

A trial of different ways of arranging the parent plants in the runner bed for virus-free runner production has been continued. The method of laying the runners into small isolated blocks appears to give useful results. (W.S.R.)

(v) *Effect of runner production.*

An extension of the above trial has made it possible to study the effect of runner production in the first year on (*a*) vigour and cropping and (*b*) runner production of parent plants in subsequent years. The plants that produced runners in 1933 bore approximately half as much fruit in 1934 as plants that produced no runners in 1933. (W.S.R.)

(vi) *Age of runner parent and spacing of runners.*

A trial is in progress to determine what difference (if any) there is between the performance of runners from one and two-year-old parents, and runners that were spaced and unspaced in the runner bed. This trial has been planned so that three spraying treatments can be superimposed. (W.S.R.)

(*c*) PLANTING, TRAINING, PRUNING, ETC.

LOGANBERRIES.

The existing loganberry training trial is being retained for one more year. The information gained from this trial will be very useful in planning a new loganberry and phenomenal berry trial, which will be planted this Winter. The trial will be carried out in collaboration with the Pathology Section and is designed to investigate the possibilities of controlling the cane-spot disease by spraying and/or training, and also to compare the pomological value of loganberry and phenomenal berry. Four methods of training are included, viz. (1) Fan, with plants at 6 feet apart in the rows, (2) one-way system with plants at 6 feet apart, (3) one-way system with plants at 12 feet apart, (4) weaving, with plants at 12 feet apart. The trial is planned so that two spraying treatments can be given. (A.B.B., J.B.M. and R.V.H.)

STRAWBERRIES.

(i) *Time of planting and warm water treatment.*

In collaboration with Entomology, a new time of planting trial has been commenced with warm water treated and untreated runners, to determine whether previous findings in regard to time of planting need to be modified when the further factor of warm water treatment is introduced. The effect of warm water treatment on runners of different sizes is also being studied.

Certain plants have been reserved for digging up in order to observe the effect of warm water treatment on the new root formation. Some idea of the initial check given by the treatment is thus being obtained. (W.S.R. and B.L.W.)

(ii) *Distance of planting.*

See below under Manuring.

(iii) *Burning.*

In collaboration with Entomology, a preliminary test of the effect of burning the straw litter after cropping was carried out. Observations on the effect of this treatment on the plants and on pests are being made.

(W.S.R. and A.M.M.)

(*d*) MANURING.

STRAWBERRIES.

(i) A trial to determine the effect of different distances of planting under four different soil fertility conditions is being prepared. The proposed manurial treatments are :

Nil, Humus, N.P.K., Humus + N.P.K., and the spacings wide, medium and close.

One medium spaced plot in each block is to be duplicated for lifting and examination of Root-rot plants (see Pathology). Crop, vigour and Root-rot records are to be taken on the rest for three or four years.

(ii) In addition to the trial mentioned above, a comprehensive trial of manures, fertilizers and methods of soil preparation is now being planned. It is intended to use clonal races of two varieties, Royal Sovereign and Tardive de Leopold, for this trial, and it will probably be planted in Autumn, 1936. (W.S.R. and I.L.-T.)

(*e*) FRUIT BREEDING.

Black Currants.

Final promising selections were made from the seven-year-old black currant seedlings, comprising crosses between the best selections from previous seedling families and the main varieties, and the plot was grubbed in the autumn. Considerable progress is being made in the analysis of many of the characters of a large number of seedlings obtained from crosses between the main varieties. The hybrid seedlings derived from crosses between the black currant, the gooseberry and *Ribes longeracemosum* were again completely sterile, although a considerable number of flowers were borne.

A number of seedlings obtained from seed subjected to X-ray treatment at the John Innes Horticultural Institution and derived from irradiated ovules and pollen, were planted out at East Malling. They are being examined to discover whether the treatment has caused any mutations.

Red Currants.

With the exception of one or two seedlings, all the Red Currant seedlings obtained from selfing the main varieties have proved to be decidedly inferior to commercial varieties, after seven years' trial, and have been discarded.

Strawberries.

A number of crosses between seedlings immune and susceptible to Yellow-Edge disease, among the families Royal Sovereign × Sir Jos. Paxton and Lefebvre × Sir Jos. Paxton, were made, in order to determine whether resistance and susceptibility to this disease are controlled by genetic factors. Two apparently resistant seedlings of promise as commercial varieties were propagated in quantity and have been planted out for further trial. Breeding work with the object of obtaining new varieties of strawberry combining high quality with resistance to Yellow-Edge disease is being arranged.

Plants of about fifty seedlings, raised and selected at the Horticultural Research Station, Cambridge, were sent to this Station, during the Spring, for trial. The seedlings are already showing striking evidence of differential susceptibility to disease.

(H.M.T.)

(*f*) FRUIT THINNING.

Gooseberries.

The experiments on these are for the present being discontinued, and a report will be issued in due course. (A.C.P.)

PUBLICATIONS DURING THE YEAR

HATTON, R. G. " Some important considerations in Modern Commercial Fruit Planting." Journ. of Royal Hort. Soc. (January, 1934). Part I. **49,** 18-36.

SUMMARY.

An account is given of the general advances made in horticultural science over the last twenty years and their interactions. A discussion of how far these can be applied in modern commercial fruit planting follows. Investigations into the " make-up " of horticultural material and of its general environmental complex when planted are shown to have profoundly influenced the planting, planning and subsequent treatment of modern commercial fruit plantations. A number of illustrations are given to show the big differences resulting from the use of different rootstocks in planning the general lay-out of apple plantations.

HAMOND, J. B. " The future of Walnut propagation in England." Horticultural Advertiser (24th January, 1934). No. 2,649, 14.

SUMMARY.

The desirability of improving the production of walnuts in this country is stressed. This work has been commenced by multiplying trees of good varieties by vegetative propagation. Twelve varieties have been chosen for propagation in this country. These include English and Foreign selections which bear nuts for either dessert or pickling purposes.

Propagation problems are discussed and a brief outline of the methods at present in use are given.

The distribution of experimental sets of young grafted walnut trees is described, and the steadily increasing demand for these trees from growers in England and abroad is emphasized. In view of this demand, it is suggested that the Trade should be invited to undertake the propagation work. Finally, mention is made of a proposed demonstration in walnut grafting, with details of material available for nurserymen who wish to take up this work.

ROGERS, W. S. " Root Studies IV. A method of observing root growth in the field ; illustrated by observations in an irrigated apple orchard in British Columbia." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 86-91.

GRUBB, N. H. and KNIGHT, R. C. " The influence of branch pruning of Cherries on the growth of suckers." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 92-3.

TYDEMAN, H. M. " The testing of New Varieties of Apple Rootstock. A progress report." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 94-9.

TYDEMAN, H. M. " New Varieties of Rootstock for Plums. A preliminary Report on trials with seedlings of *Prunus divaricata.*" E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 100-2.

GARNER, R. J. " A method of converting unprofitable fruit trees." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 103-7.

ING, E. G. " Plum Rootstocks—A Note on some Root-systems." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 108-10.

HATTON, R. G. and BAGENAL, N. B. " Scion Rooting at E. Malling Research Station." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 243-6.

BEAKBANE, A. B. " A note on the Training of Loganberries and Blackberries." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 247-9.

HAMOND, J. B. " Some recent investigations into methods of storing Walnuts during the Winter." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 259-62.

GARNER, R. J. " The use of rubber strips in budding fruit trees." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 263.

ROGERS, W. S. and VYVYAN, M. C. " Root Studies V. Rootstock and Soil effect on Apple Root Systems." Journ. of Pom. and Hort. Sci. (July, 1934). **12,** 110-50.

SUMMARY.

1. The complete root-systems of twenty-six Lane's Prince Albert apple trees, ten- and eleven-years-old, on various clonal rootstocks, were excavated from three soils; Loam, Sand and Clay.

The root-systems covered a very wide range of vigour, from very dwarf (e.g. Malling, No. IX) to very vigorous (e.g. No. XVI). The trees were planted as stock trial plots, and form a truly comparable series.

The extent, amount and position of the root-systems and their relation to tree performance and to the soil profile was studied. These points are illustrated by photographs of reconstructed root-systems, and by root plans, besides diagrams and tables.

2. In all cases the roots spread farther than the branches. In the sand the root spread was two to three times the branch spread. In the loam and clay it was about one and a half times the branch spread. The ratio of root spread to branch spread was slightly higher in the more vigorous than in the more dwarfing stocks.

3. The fine fibrous root occurred everywhere and grew in all directions including upwards. It was distributed over the whole root-system. Only about 10 per cent. of the fibre was in the square metre of soil surrounding the trunk of ten- and eleven-year-old trees on loam. Nearly half the fibre was outside the 3 metre square surrounding the trunk. Hence, for most efficient feeding, manure needs to be spread over the whole root area, reaching beyond the branch spread.

4. The root depth varied considerably on the different soils. On the loam there was a fairly shallow scaffolding of main roots about 20 to 33 cm. deep, from which numerous vertical roots descended to the rock at all distances from the trunk. These roots often turned horizontally along the rock and ramified profusely in the sticky B horizon just above it. The rock occurred at depths varying from 100 to 300 cm. below these trees. The deepest roots found reached 296 cm. (over 9 ft. 6 ins.) These were on Stock No. IX.

5. On Stocks IX (very dwarfing) and II (semi-dwarfing), about half the total root weight and three quarters of the fibre was below 33 cm. and three-fifths of the fibre was below 50 cm. Stocks I (vigorous) and XVI (very vigorous) were relatively shallower, having only a quarter of their total root weight and half their fibre below 33 cm., and about two-fifths of the fibre below 50 cm. This variation in depth was probably partly due to deeper rock below Stocks IX and II.

It is clear that a dwarf tree is not necessarily shallow rooted, for in this case the smallest trees had the deepest roots, and the largest trees had the shallowest. The great depth of many of the roots explains why manures applied to the surface may take several years to show an effect.

6. The roots on the sand were shallower than on the loam. The same general conformation of a shallow scaffolding with vertically descending roots was found. In this case there was no clearly defined depth boundary. The maximum depths found were No. IX, 80 cm.; No. II, 137 cm.; No. I, 115 cm.; No. OF5, 190 cm. In most cases more than three-quarters of the total root weight was less than 30 cm. deep.

7. In the clay the main scaffolding of roots was deeper than on the sand or loam. Most of the roots sloped down and grew along in the sticky subsoil between 30 and 60 cm. deep. Branch roots grew upwards and downwards. There was a very sharply marked depth boundary at about 90 cm. Though a few young roots had penetrated to 118 cm., there were signs of killing back to the 90 cm. level. This suggests a seasonal water table cutting off aeration.

8. The trees varied greatly in weight and in the amount of fruit they had produced, according to the stock on which they were worked and the soil on which they grew. The ratio of stem weight (i.e. trunk and branches) to root weight was comparatively constant on a given soil, however, irrespective of the size of the tree and the crop it had borne. The stem/root weight ratio varied between different soils. On the loam it was from about 2·0 to 2·5, on the clay it was about 2.1, and on the sand it was from about 0·7 to 1·0. Hence it requires more than twice as much root to support a given amount of top on the poor sand as on the loam or clay.

9. The type of root was modified by the soil. In the sand the roots were long, thin, straight and spreading. In the clay the roots were fairly short, tapering, rapidly branching, and twisting in all directions. In the loam they were intermediate in form between those in sand and those in clay.

10. In spite of the modifying influence of the soil the roots of the different stocks were recognizable by their distinctive characteristics. Neither the soil nor the scion variety had eliminated the original stock differences in ten years.

Amos, J. "Reversion in Black Currants." Amateur Gardening (7th July, 1934). No. 2618. 233.

Summary.

A short account of the methods to be followed in diagnosing the symptoms of reversion in black currants. Directions for distinguishing between true and false reversion are given together with the steps which should be taken to prevent the spread of the disease.

Hatton, R. G. "Fruit Growing should no longer be a Gamble." Farmer's Weekly (2nd November, 1934), No. 20, **1**, 13.

Summary.

The would-be fruitgrower must take into account a host of important factors, such as soil, climate, variety, rootstock, manuring, spraying and pruning; and he must evolve a definite plan of action covering a period of years. He is engaged in a battle with Nature and must become conversant with the rules of strategy and tactics. These were once no more than hazy traditions, but research stations are now rapidly arranging them into a rational code.

The fruit farmer must of necessity be something of a gambler, for he deals in a highly perishable product, very sensitive to climatic conditions and the vagaries of the market. But thanks to science and practical experience it is now possible to load the dice a little in his favour.

The nation that is prepared to spend generously on research will give its fruit-growers the blessing of certainty and its public a regular supply of well-grown, health-bringing fruit.

HATTON, R. G. " Rootstocks for Pears." Report of the Royal Hort. Soc. Conference on Apples and Pears, 1934, (see p. 75 of this Report).

TYDEMAN, H. M. " Fruit Growing in Kent." Kent County Journal (Autumn, 1934). **2,** No. 5, 12-15.

SUMMARY.

This paper comprises a short popular account of fruitgrowing in the county of Kent. The origin and history of commercial fruitgrowing in the county are briefly described and the relative merits of intensive and extensive methods of fruit culture discussed. The latest findings on manuring, rootstocks and varieties are dealt with in relation to modern commercial fruitgrowing practice.

HATTON, R. G. " East Malling's Experiences with Apple Rootstocks." Paper read at Growers' Day Conference, Imperial Fruit Show, Leicester, November, 1934. (See p. 223 of this Report.)

PAINTER, A. C. and ROGERS, W. S. " The Thinning of Fruit for High Grading." The Farmers' Weekly (6th July, 1934), No. 3, **1,** 38.

SUMMARY.

The thinning of apples, plums and pears is shown to increase size and colour of fruit, to reduce amount of culls, to maintain tree vigour and reduce risk of branch breakage. On apple trees in full bearing thinning in June or July, leaving only one apple to a cluster, is recommended. With plums such as Victoria, spacing to an inch apart is worth while. In practice there is little risk of thinning too severely—growers seldom remove enough.

BANE, W. A. and JONES, G. H. GETHIN. " Fruit Growing Areas on the Lower Greensand in Kent. A Survey of the Soils and Fruit, 1928-1931." Bull. Min. Agric., London, 1934, **80,** 81 pp.

SUMMARY.

This survey, carried out by the staffs of East Malling and the South-Eastern Agricultural College, Wye, in collaboration, is one of a number made in different fruitgrowing areas of the country with the aid of the Fruit Soils Survey Committee of the Ministry of Agriculture, and fulfils a need indicated in 1911 by Hall and Russell in " A Report on the Agriculture and Soils of Kent, Surrey and Sussex." The bulletin is divided into four parts :—In Part I are described the geology of the district, the process of soil formation and the method of soil surveying employed. The system of soil classification used is based on the American method, in which the soils are grouped into series according to their characteristics and natural properties, as exhibited by their examination in the field. The geology and the positions that the soil series typically occupy are illustrated by a map and a diagrammatic section. Part II deals with the history and present position of

fruitgrowing in the area and with general pomological investigations. The data on distribution of varieties, rootstocks and incidence of diseases and pests are summarized and tabulated. One of the main functions of the survey was to decide the comparative parts played by soil and climatic and management factors on observed differences of growth. These factors are discussed and illustrative examples described. The results of the correlative work are given in Part III, where the soil series are described and the relation between tree growth and soil conditions discussed for each, reference being made to any preference of kind or variety of fruit. A tabular summary of the chief characters of the soil series and their influence on the growth of fruit trees is given. Conclusions are given in Part IV. Briefly stated they are as follows :—As a whole the Lower Greensand is undoubtedly very fertile for growth of tree and bush fruits. There are, however, some series which are better or worse than most, some of these exceptional soils being widespread and others limited in extent. Soil water conditions are of great importance in this differentiation. The terms " good " and " bad for fruit " cannot be applied to a soil series without qualification while management factors may play an important part in overcoming soil effect. There is a marked preponderance of culinary over high-class dessert varieties in the area, possibly due more to widespread condition of excess nitrogen resulting from the usual manurial practice for hops than to inherent unsuitability of the soils for production of high-class dessert fruit. It is now possible to indicate how the area under fruit can be most profitably extended and the new land planted to the best advantage. Twenty-four photographs illustrate soil profiles and the effect of soil and management factors on tree growth.

ROGERS, W. S. " Researches on Fruit Tree Root Systems." Scientific Journ. of Royal Coll. Science, 1934. **4,** 120-9.

SUMMARY.

The rootstock exercises an important measure of control over tree performance, including vigour, cropping, disease resistance and other characteristics. By use of standardized stocks, kept true by vegetative reproduction, a definite standard of tree performance can be obtained.

The soil has a great effect upon the root-system. The stock can be chosen to suit the soil, variety, and purpose for which it is required.

The roots usually spread much farther than the branches, and the fine absorbing roots are fairly evenly spread over the whole root-system. For most efficient feeding fertilizers need to cover an area even wider than the branches. Many roots are quite deep below the surface, fertilizers applied to the surface may therefore take a long time before showing any effect.

For the full understanding and control of the tree it is essential to know not only where the roots are, but when and where they grow and how they react to various factors. The methods devised for studying established root-systems and growing roots are briefly described.

HOBLYN, T. N. and BANE, W. A. " Apple Manurial Trials. Part I. The Renovation of Unmanured Trees. Part II. The Treatment of Trees under Grass." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 59-85.

HOBLYN, T. N. and PALMER, R. C. " A Complex Experiment in the Propagation of Plum Rootstocks from Root Cuttings. Season 1931-32." Journ. of Pom. and Hort. Sci. (March, 1934). **12,** 35-56.

Summary.

1. A complex experiment, including several factors relative to the propagation of plum rootstocks from root cuttings is described ; the advantages of this type of experiment are discussed.

2. The layout of the experiment is described.

3. The methods of making and treating the cuttings, and recording their survival and subsequent growth are included and the practical disadvantages of this method of propagation, as compared with that of stem cuttings in a variety that is easily propagated in this way, are pointed out.

4. The analyses of the numbers of those cuttings which were alive at the end of the first season and the growth which they had made are described and the results enumerated.

5. Whereas the variety Pershore Egg did not respond to this method of propagation, a considerable degree of success was attained with Common Mussel.

6. In this rather mild winter there was little difference in survival or growth of those cuttings made and planted in October, December, January and February. Those made and planted in April had a somewhat lower survival and made very poor growth.

7. Bedding in sand until the spring was, under the conditions of this experiment, always detrimental.

8. Size of cutting had a considerable influence on the survival, both length and diameter being of importance. Cuttings 9 cm. in length and not less than 6 mm. in diameter would seem on the whole likely to give the best results.

STATISTICS AND RECORDS

The analysis of the records on some of the newer trials continues to justify the more complex type of experiment. In particular, analyses of the results of the series of manurial trials on apples have yielded interesting results.

These experiments are of two types (i) a complex experiment involving the differential manuring of two varieties on different rootstocks from the start, (ii) a simpler layout on established plantations of mature trees. In both types the statistical device known as the " analysis of covariance " has proved useful in interpreting the results in light of the previous history of the trees, either previous to planting or in the field. An account of the latter experiments has been published during the year in collaboration with the Pomological Section (E72).

Plot Layout.

The uniformity trial of strawberries has yielded its first crop and the yields of some 1,460 plants were individually recorded. Upon these results has been based the layout of a number of trials to be planted during the ensuing year.

Plans have been drawn up for a complex cordon apple experiment and a comprehensive trial of loganberries. In both these trials provision has been made for further series of treatments which it may be desirable to superimpose at a later date.

An experiment has been commenced, which is designed to show seasonal effect upon certain nursery problems, such as incompatibility. This will be planted annually.

Records.

The work of the record office has not diminished. However, it is now possible to keep pace with the demand for easily digestible summaries, either for published reports or exhibits.

Technique of Recording.

A very heavy crop has brought a new series of sampling problems. Sampling methods have now been devised for extension growth (on pruned and unpruned trees), time of blossoming, relative amount and set of blossom, size and colour of fruit. The adequacy of these records is being tested as opportunity offers.

It has not been possible during the past year to do more than add another season's records to the work on the relationship between the various aspects of vigour in fruit trees, but this work is being continued and extended now. (T.N.H.)

A new technique of weighing the fruit in the orchard has been introduced to cope with the increasing crops of our experimental trees as they reach maturity. The fruit from each large tree is now weighed in the orchard boxes instead of in picking bags, so reducing considerably the number of weighings. A 60 lb. spring balance suspended by pulleys from a tripod and raised by means of a lever is used for this purpose. A special clip has been devised for holding the boxes. This technique has proved very satisfactory. New metal sided picking buckets have been used, to overcome the bruising found in canvas picking bags. Automatic counters have been successfully fitted to these picking buckets to record the number of fruits, but it is found that the necessity for placing the fruits in the bucket singly inevitably slows down the picking. (W.S.R.)

PUBLICATIONS DURING THE YEAR.

HOBLYN, T. N. and BANE, W. A. " Apple Manurial Trials. Part I. The Renovation of Unmanured Trees. Part II. The Treatment of Trees under Grass." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934), 59-85.

HOBLYN, T. N. and PALMER, R. C. " A Complex Experiment in the Propagation of Plum Rootstocks from Root Cuttings. Season 1931-32." Journ. of Pom. and Hort. Sci. (March, 1934), **12,** 36-56.

For Summary of this paper see under Pomology, p. 51.

PHYSIOLOGY

VEGETATIVE PROPAGATION (with Propagation Section).

(*a*) *Cuttings.*

Experiments on maintaining moisture conditions favourable for rooting, by use of humus layers, watering and shading, are being continued. Further experiments are in progress on the effects of etiolation, leaf removal, and time and depth of planting. Cuttings of plum shoots off layers that had received different manurial and pruning treatments have been planted to determine whether these treatments have an after effect on rooting.

The course of root, leaf and stem growth in cuttings of a plum stock has been followed by the sampling method during 1934. Interesting results were obtained which are being followed up during the coming year.

(*b*) *Layers.*

An investigation on a large scale has been carried out on the effect of different manurial treatments and different times and types of summer pruning upon the development and rooting of shoots on layers of two varieties of plum stock. Hardwood cuttings have been taken from these shoots and planted as described above.

(R.J.G., R.C.K. and M.C.V.)

LEAF RELATIONS IN APPLES.

The Distribution of Leaf Surface.

Work is being continued on sampling methods for determining leaf surface on large trees, and for early detection during Summer of growth responses to different treatments. (M.C.V.)

CARBOHYDRATE RELATIONS.

Work on this line has been discontinued for the present as the worker concerned has left to take up an appointment elsewhere. (E.L.)

GROWTH.

Seasonal Course of Root and Shoot Development.

A further paper on results obtained from the unworked apple stock No. XIII has been published (F17). The total annual increment in weight was found to be distributed in approximately constant proportions between roots, stems and leaves, irrespective of the size or age of the tree. It is pointed out that this explains how the constant stem/root ratio, found for trees of a given scion-stock combination on a given soil, is attained and maintained, and suggests a mechanism for some aspects of scion and stock effect on vigour.

The trees of the two scion varieties, each on four rootstocks planted last year, are being sampled according to plan. The results so far obtained during the first year after planting indicate interesting differences in the leaf/root ratio on different rootstocks at

mid-summer. Trees of six of these scion-stock combinations were grown in soil in glass-fronted rootboxes, and their root-stem and leaf growth recorded.

The experiment is to be repeated with a second series of trees that are being planted this Winter, and material is being prepared for a more comprehensive experiment on similar lines, to be begun in 1936.

(M.C.V.)

Effect of Scion on Root.

The morphological analysis of the trees mentioned in the last report has been begun. (M.C.V.)

Size of Tree in Relation to Other Measurements.

The results described under this head in the last report have now been published (F14). Work is in progress on the relation between the diameter of a tree or branch and the weight of the portion above the point where the diameter is taken. (R.C.K.)

Pruning.

The results described under this head in the last report have now been published (F15). (R.C.K.)

Double Working.

The results of an experiment on the relative importance of the stock root-system and the stock stem in stock effect on the scion have been published (F16). The material consisted of four series of double worked trees comprising the four possible combinations of two root-systems (one dwarfing and one vigorous) and two intermediates (of the same varieties as the root-system) with the same scion.

The results over a six year period, confirmed the conclusion indicated in a previous progress report, based on three years' records, that the root-system of vegetatively raised stocks is more important than stock-stem in determining scion performance. (R.C.K.)

Excavation of Root-Systems.

The results of these investigations, carried out in collaboration with the Pomological Section, have now been published (*vide* Pomology, E75). (W.S.R. and M.C.V.)

PUBLICATIONS DURING THE YEAR

Knight, R. C. "The Influence of Winter Stem Pruning on subsequent Stem- and Root-Development in the Apple." Journ. of Pom. and Hort. Sci. (March, 1934). No. 1, **12,** 1-14.

Summary.

Experiments have been carried out on an extended scale in order to amplify the results obtained in a previous investigation on the influence of winter stem pruning on subsequent stem and root development. Some five hundred trees were used, including various combinations of stock and scion and these were subjected to several different degrees of stem pruning.

Confirmation was obtained of the results previously recorded that the subsequent production of new roots is decreased and that of new shoots is increased by pruning,

unless the treatment is very severe, in which case new shoot production may also be decreased. The age and condition of the buds which are induced to develop by pruning appear to influence the weight of new shoots produced.

In addition it was found that pruning decreases the thickening of old stems so much that any increase in new shoots is more than counterbalanced and thus total stem-growth shows a decrease.

Pruning diverts a proportion (depending on the severity of treatment) of the effort normally directed to thickening of old stems, to the production of new shoots.

Although stem pruning has a considerable influence on the size of the root-system, there is no evidence of a change of root character.

The ratio of new stem-growth to new root-growth remained remarkably uniform under all conditions of pruning irrespective of large changes in the actual amounts of both stem and root.

It is suggested that after transplanting although postponement of pruning until the second year will result in greater increment of both roots and total stem, if considerable extension growth is required, even at the expense of obtaining the maximum of new roots, immediate pruning is desirable.

KNIGHT, R. C. " Further Observations on the Parts played by Root and Stem in Stock Influence." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 114-16.

KNIGHT, R. C. and HOBLYN, T. N. " The Effect of Size of Tree on the Relations between Various Records of Roots and Stems of Apples." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 117-21.

VYVYAN, M. C. " The Distribution of Growth between Roots, Stems and Leaves in a Young Apple Tree and its possible bearing on the Problem of Stock Effect on Tree Vigour." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 122-31.

BIOCHEMISTRY

Mutual Influence of Rootstock and Scion.

(*a*) *Elementary Analysis.*

Experiments have been continued to determine how far rootstock effect may be expressed in terms of the selective action of the roots etc. in absorbing elements from the soil and supplying them as raw materials to the scion ; how far the effect of soil type may be expressed in terms of the elements extracted by trees from different soils ; and consequently, in each case, how far these effects may be imitated by manuring, injection, etc., and how far seedlings with desirable qualities may be selected by chemical analysis.

(i) *Polarographic.* The co-operation of a worker at the Imperial College of Science, London, has been obtained in an attempt to render this method suitable for routine use.

(ii) *Spectrographic.* A new method has been devised, preliminary results with which suggest that it has certain unique advantages.

(*b*) *Organic Analysis.*

Work has been continued to determine how far rootstock effect, etc., may be expressed in terms of organic compounds synthetized in the tree ; how far such desirable effects as precocity, disease resistance, etc., may be imitated by injecting suitable organic compounds ; how far seedlings with desirable qualities may be selected by chemical analysis, and how far varieties may be identified by chemical methods.

Methods for extracting the constituents of bark and wood unchanged have been improved. After preliminary isolation of constituents the preparations are being sent to Professor R. Robinson of Oxford for identification. It is hoped that from this collaboration will result a survey of the chemical constituents of fruit trees which should lead to a more accurate knowledge of their physiology and should facilitate more rapid progress in such investigations as that of the nature of resistance to Woolly Aphis.

Tree Injection.

(*a*) *Distribution.*

Further difficulties have been encountered and overcome. Two preliminary reports (K8, K9) have been published and a third detailed paper is ready for publication. The methods evolved are being applied in many places overseas.

(*b*) *Avoidance of Damage.*

As a result of the application of the principles referred to in last year's report (see publication K11), no appreciable damage has followed any injections carried out this year.

(*c*) *Results of Injection.*

(i) Artificial Manures. The injection of Cox's Orange apple trees in a commercial plantation with a solution containing 0·25 per cent. dipotassium hydrogen phosphate

plus 0·25 per cent. urea in June, led to marked improvement in foliage texture, an effect on fruit colour, and an increase in amount of wood growth.

(ii) Iron salts for chlorosis. The nature of an extreme case of chlorosis in a valuable peach tree at the Swanley Horticultural College was diagnosed by small shoot-tip injections ; and the scale of the injection was increased in two further stages until the whole tree was injected. A fortnight after the last injection, the whole tree had recovered its normal foliage colour. Although the fruitlets had remained stationary for weeks prior to the injection, afterwards they grew and nearly a full crop was eventually produced and marketed. The experience obtained will be applied to the remaining trees, all of which are developing the disease. Similar work has been commenced in a large commercial plantation of pears and apples similarly affected. The preliminary results so far obtained are most encouraging.

The injection methods have been simplified still further, so that the total cost of injecting a tree amounts to a few pence only. (W.A.R.)

Causes of Resistance to Woolly Aphis.

(See Entomology Section.)

PUBLICATIONS DURING THE YEAR

Roach, W. A. " Budding and Grafting Razors." Gardeners' Chronicle (24th March, 1934). No. 2465, **95,** 196-7.

Summary.

Machinists' drawings and descriptive notes are provided for making handles to hold safety razor blades (1) for grafting work with potatoes, strawberries and other herbaceous plants and (2) for the patch grafting and budding of raspberries, walnuts, etc.

Roach, W. A. " Tree Injection. A Progress Report." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 137-41.

Roach, W. A. " Injection for the Diagnosis and Cure of Physiological Disorders of Fruit Trees." Annals of Applied Biology (May, 1934). No. 2, **21,** 333-43.

Summary.

Water and sand-culture methods are of somewhat limited applicability to fruit trees.

The interpretation of the results of manurial experiments, whether conducted in the field or in pots, are complicated by base exchange and similar phenomena. Direct injection of solutions into trees is, therefore, suggested as an additional method for studying, and possibly even curing, physiological disorders, especially those of the " deficiency type ". Methods for injecting whole trees, separate branches, with or without their corresponding roots, or separate twigs are described.

Some effects of injection on the vigour of the tree and on disease are mentioned.

Thomas, L. A. and Roach, W. A. " Injection of Fruit Trees : Preliminary Experiments with Artificial Manures." Journ. of Pom. and Hort. Sci. (July, 1934). No. 2, **12,** 151-66.

Summary.

1. The possibility is discussed of diagnosing deficiency diseases by injection experiments in the actual plantation and even of curing the diseases in certain cases by the same method.

2. The serious damage which sometimes results from the injection of nutrient salts has up to now made the use of this method risky.

3. This damage has been shown to vary according to :

i. the variety ;
ii. the rootstock on which the tree is worked ;
iii. the compound in which the element is injected ;
iv. the concentration of the injected solution ;
v. the total amount of substance injected.

4. Varying amounts of an injected substance caused equal damage when the volume of the solution increased as the square of the amount of substance.

5. 0·25 per cent. solutions of all the nutrient salts tested may be injected with safety. Sufficient quantities are absorbed in about twenty-four hours to bring about growth increases as great as any caused by the heaviest applications to the soil.

6. All nutrient elements may be injected without ill effects if suitable compounds are selected and if they are dissolved in sufficient water.

7. Two growth increases resulting from the injection of nutrient salts are mentioned.

PLANT PATHOLOGY, MYCOLOGY AND BACTERIOLOGY

Crown Gall.

An experiment was carried out in the greenhouse to test the effect of the application of sodium nitrate to young apple trees inoculated with the Crown Gall organism *Bacterium tumefaciens*. The results were irregular and there was no evidence that sodium nitrate, applied to the soil, stimulates the development of galls. In this experiment more galls developed on the control trees than on those receiving nitrates. (H.W.)

Brown Rot Diseases of Fruit Trees.

In continuation of an experiment, during which it was ascertained that a Shoot Wilt in layer beds and stools of plum stocks was caused by *Sclerotinia cinerea*, one of the Brown Rot fungi, attempts were made to determine whether infection arose from the soil. No infection resulted from applying soil taken from pots in which the disease had been present the previous year.

Observations have been made on the incidence of fruit rot, caused by *Sclerotinia fructigena*, on plums in cold store. (H.W.)

Bacterial Diseases of Fruit Trees.

Bacterial Canker of Plum Trees.

Experiments, in pot cultures and in field plots, are being continued to determine whether cultural conditions have any effect on the predisposition of trees to Bacterial Canker.

The results of certain field observations and experiments on plum bacterial canker have been published (C96). These results show that (*a*) pruning or cutting back plum trees in Autumn is to be avoided as bacterial cankers may arise at the cut surfaces, (*b*) the variety Victoria when worked high (stem as stock) on Myrobolan B or Common Plum had a lower percentage of trees killed by bacterial canker than when worked low (stem Victoria), (*c*) on manurial plots, potash, applied to budded trees during the year the buds grew out, had no restraining effect on the incidence and development of bacterial canker on maiden trees.

Bacteriosis of Cherry Trees.

Organisms isolated from cherry leaves, branches and stems are being compared with each other and with the organisms causing Shoot Wilt (*Pseudomonas prunicola*) and Bacterial Canker (*Ps. mors-prunorum*) of plum trees.

Tests of Bactericides.

Various bactericides are being tested *in vitro* on the bacterial canker organism in order to evaluate them with reference to the possibility of using them in field trials. (H.W.)

"Fruit-Russeting" and "Branch-Blister" Disease.

A study of the effect of manurial treatment on russeting in Cox's Orange Pippin is under way.

Pure cultures of the associated fungus-types from a number of different sources have been grown and kept in stock, but no further inoculations have been made.

Further specimens of branch-blister have been received from various commercial sources, and all possible data is being obtained concerning them, in order to ascertain the relation that this disease bears to soil conditions.

Fungicide-Insecticide Trials.

A report on a re-planned spraying and dusting trial carried out in 1931 and 1932 was published during the year (C94). Lime-sulphur again proved to be the most desirable agent of those tested for Scab-control, while dusting with sulphur showed promise as an adjunct to spraying.

An account was published (C98) of the first year's progress (1933) towards determining the relative efficiency of complete minimum spray-programmes of fungicide-contact insecticide washes on Cox's Orange Pippin for the simultaneous control of certain insect pests as well as of Scab. Excellent control of Scab and Red Spider was obtained by lime-sulphur in the very dry season experienced. Two pre-blossom sprays were not more beneficial than one. Derris and nicotine, respectively, with sulphite lye as wetter, were used in combination with lime-sulphur. Nicotine gave very good control of Apple Sawfly in the egg stage (a new point in the control of that pest), but Derris was only half as effective in this respect. Certain brief suggestions for the control of Apple Sawfly, based on this work, were published in collaboration with the Entomology Section (D101).

This line of work was continued in 1934. Lime-sulphur was used as standard fungicide, together with lead-arsenate pre-blossom and nicotine post-blossom as insecticides. Three different wetters were compared at petal-fall, but the classified results are not yet available.

Spreader Trial.

Tests of the value (for the control of Scab and certain insect pests) of different spreaders, in combination with lime-sulphur as standard fungicide and nicotine as standard insecticide, have been continued. These are still at a preliminary stage, as the tests are being made on young trees not yet in full cropping, but some promising results have been obtained.

Spray-Injury Trial.

Data have been obtained for a second year from tests designed to determine whether the injury caused by lime-sulphur and lead or calcium arsenate can be reduced through the inclusion of ferrous sulphate in the spray-mixture [see Pomology (*k*)]. The trial will be continued, for the results to date are not sufficient to be conclusive.

Factors Affecting Susceptibility to Apple Scab.

Further data on the effect of rootstock and manurial treatment on susceptibility to scab in Bramley's Seedling, Worcester Pearmain and Cox's Orange Pippin were obtained during the year [see Pomology (*h*)]. The results concerning the first two varieties have been obtained over a number of years, and they will be published as time allows.

Apple Scab in Storage.

Observations have been made of Apple Scab on apples during storage (C105). The lesions developing during storage are different in appearance from ordinary scab spots on fruit in the open, although caused by the same fungus. The larger lesions which develop in storage are sunken (saucer-shaped) and pitch black ; such spots may develop fungal fructifications bearing spores. The smaller spots are lobed, more superficial and do not bear fungal pustules.

Apple Canker.

In connection with the fungicide trials, records have been taken for a number of years on the incidence of apple canker (*Nectria galligena*) on Cox's Orange Pippin and Stirling Castle, each worked on a number of different rootstocks. These were summarized and published as a report (C99). Results showed that spraying for scab-control had in this experiment little, if any, effect on canker. The rootstocks, however, showed marked differences in inducing susceptibility in the scion, trees on No. XIII and on No. XVI being more prone to attack than those on other stocks.

The importance of cutting out all infected tissues was shown, but a trial of different materials used as protective paints on the cut surfaces was inconclusive, owing to lack of infections in the wounds.

Raspberry Mosaic Disease.

(1) *Analysis of Symptoms and varietal Susceptibility.*

The study of the North American virus diseases of raspberries in relation to those occurring in Great Britain commenced in June, 1933, and continued during 1934. By means of a grafting method, the leaf-curl disease and the Mosaic disease commonly occurring on red, purple and black varieties of raspberry in North America were transmitted to virus-free plants of (1) the English "index varieties" *Lloyd George* and *Baumforth Seedling B* and (2) the American varieties *Cuthbert* and *Viking*. The reaction of these diseases on the two former varieties was strikingly different from that obtained when the forms of raspberry mosaic disease occurring in Great Britain were transferred to the same index varieties in the parallel experiments carried out at East Malling. Concurrently with these experiments, observations on the incidence of virus disease on local American varieties of raspberry and on imported English varieties (Lloyd George in particular) were made throughout the Niagara peninsula and in other and widely separated districts in North-Eastern America. In June, 1934, the field of observation was extended to British Columbia.* This widespread survey of raspberry virus disease in North America in conjunction with the results of the experiments at the St. Catherines' laboratory confirmed the probable non-occurrence of American leaf-curl in Great Britain, and indicated a possible distinction between the analagous mosaic diseases in the two countries. The investigation is being continued in collaboration with the Dominion Laboratory of Plant Pathology at St. Catharines, Ontario.

(2) *Experiments in Commercial Control.*

Further inspections of the Research Station nursery (for the propagation of virus-free canes) now in its seventh year, and of the five extension (Lloyd George) nurseries, now in their fourth year, were made with satisfactory results, no additional cases of infection being found in the former and only eight definite cases in the latter.

* At the invitation and by courtesy of the Canadian Federal Department of Agriculture.

Initial surveys of a fruiting plantation planted in 1933 with Lloyd George cane obtained (1) from Scotland (Blairgowrie district) and (2) from each of three of the above extension cane-nurseries showed a very low percentage of definite cases of mosaic on the stools from each of these sources, those from Scotland showing a markedly higher percentage (4½ per cent.) than those from the extension nurseries (0·05 per cent.)

(R.V.H. and N.H.G.)

Loganberry Cane-Spot.

Experiments in the control of this disease were continued and yielded promising results as follows:

(*a*) *Spraying Experiments.* A measurable degree of control of the leaf-spot phase was obtained by an application of a lime-sulphur spray either immediately before the blossom period or (in combination with Derris for beetle control) at the standard time for beetle control. The most satisfactory results obtained hitherto in these experiments resulted by spraying at both these stages.

(R.V.H., J.B.M. and W.S.)

(*b*) *Modified Training.* As in the previous season a marked degree of control was obtained by the use of certain modified training methods as compared with those in general use by growers. A long period experiment is being planned to determine, among other issues, the cumulative effect on cropping of each of the above methods alone in and combination. (A.B.B., R.V.H. and J.B.M.)

Virus Diseases of Strawberries.

General.

The relation between virus diseases and "degeneration" in strawberries has been summarized (C100).

(i) The wide recognition by American workers of the possible relation of virus factors to failure in strawberry plantations is shown by a survey of the relevant publications appearing in the American strawberry-disease literature of recent years.

(ii) The publications on this subject by workers in Europe during the post-war period are reviewed; it is shown that whilst many workers have suspected the occurrence of a pathological factor of the virus type in certain commercial varieties of strawberries, the identification of such a factor has been complicated by the masking effects of climate and of infestations by eelworm, insects and mite.

(iii) Recent experiments at East Malling are cited in which the incidence in Great Britain of a virus disease of the variety Royal Sovereign closely similar in its symptoms to Xanthosis in America, was determined by means of a grafting technique devised for the purpose. (R.V.H.)

The "Yellow-Edge" Disease of the Strawberry.

During the year the study of virus diseases of the strawberry in Eastern Canada and U.S.A. in relation to the above disease was continued at St. Catharines, Ontario.

By the use of a grafting technique the disease occurring on varieties grown on the Niagara Peninsula and closely analogous to the Xanthosis disease in California was

transferred to virus-free *Royal Sovereign* plants. The symptoms which developed on these plants were indistinguishable macroscopically from those occurring on plants of this variety infected with the yellow-edge disease in Great Britain.

Further results of these experiments indicated the necessity for testing material used in the study of the "root rot" complex for freedom from virus factors and this aspect of the investigation is being continued in collaboration with the Dominion Laboratory of Plant Pathology at St. Catharines, Ontario. (R.V.H.)

Root Rot of Strawberries.

Work on this disease, initiated by Dr. Berkeley from St. Catharines, Ontario, in 1933, was continued in 1934 and reports published (C97, C101 and C104). The root rot disease is characterized by a general dwarfing and flattening of the plants, without the yellowing or distortion associated with mite or aphid attack and "yellow-edge" disease. The roots show black lesions, and various fungi have been isolated from such lesions. These fungi have been used in inoculation experiments and five of them have been found to induce root rot in pot experiments, viz. *Coniothyrium Fuckelii* Sacc., *Hainesia Lythri* (Desm.) v. Höhn., *Cylindrocarpon radicicola* Wr., *Fusarium orthoceras* App. and Wr., and *Pachybasium candidum* Sacc. (I.L.T.)

Walnut Graft Disease.

Further work has been carried out on this disease and the fungus associated with it. The morphology and cultural characters of the fungus isolated from diseased grafts have been studied and compared with those of other strains isolated from a walnut root, carrot, and peach seedling. Certain differences under cultural conditions have been noticed. The value of formalin in reducing the incidence of the disease has been proved. (J.B.H.)

Intumescences on Vine Leaves.

Enquiries as to the cause and control of intumescences or œdema on vine leaves resulted in the publication of a brief note (C103) in which it was pointed out that this condition occurs when the atmosphere of the greenhouse is kept too moist, or when the roots are too active, as might obtain in a moist warm soil. (H.W.)

Tomato Virus Diseases.

In collaboration with workers at the Research Stations at Cheshunt and Harpenden, experiments have been carried out here by Dr. Berkeley from St. Catharines for comparing the symptoms induced on tomato plants by inoculating them with certain English and Canadian viruses.

PUBLICATIONS DURING THE YEAR

Harris, R. V. "The 'Degeneration' of the Strawberry. II. Virus as One Cause of Strawberry Degeneration." Imp. Bur. Fr. Prod. Tech. Comm. No. 5 (February, 1934). 11-15.

Summary.

A review is made of the published observations, researches and conclusions of American and European workers from the point of view of their contribution to our knowledge of the part played by virus in the commonly occurring deterioration of strawberry plantings.

BERKELEY, G. H. " The ' Degeneration ' of the Strawberry. III. The Phenomenon of Root Rots in connection with Strawberry Degeneration." Imp. Bur. Fr. Prod. Tech. Comm. No. 5 (February, 1934). 16-19.

SUMMARY.

A review is given of the literature bearing on the condition of disease in strawberry plants known as Root Rot. Plants with this disease are of low vitality, usually stunted, and they have a tendency to die out under dry-weather conditions. Such plants on being dug up have black roots, or in the earlier stages the roots bear black lesions. This disease has been investigated by a number of workers in North America, and various fungi have been found associated with this condition. Root Rot has also been studied in Australia, in Scotland, and recently in England. The general conclusions drawn from a consideration of the work on the subject are : (1) Root Rot of strawberries is widespread and it is an important factor in the deterioration of the strawberry (2) Though the symptoms of the various root rots may be similar the causal organisms are not necessarily the same.

The control measures generally recommended are (1) crop rotation, (2) planting up runners with clean white roots taken preferably from a plantation free from root rot.

MOORE, M. H. " Spraying and Dusting Experiments on the Control of Apple Scab (*Venturia inaequalis*) and Apple Mildew (*Podosphaera leucotricha*) at East Malling in 1931-1932." Journ. of Pom. and Hort. Sci. (March, 1934). No. 1, **12,** 57-79.

SUMMARY.

Field trials of sprays and dusts against Apple Scab and Apple Mildew on Cox's Orange Pippin were carried out in 1931 and 1932. These are described and the results are fully tabulated and discussed in relation to weather conditions. Certain opinions are offered concerning methods of expressing and interpreting the tabulated results. Observations on experimental dusting methods are also noted.

Former results are largely supported, though, for the first time during the last seven years, seasonal conditions rendered two pre-blossom sprays necessary for excellent scab-control at East Malling in 1932. A " half-strength " Bordeaux mixture caused no damage in 1932, but it gave indifferent control of scab. Colloidal sulphur, less effective than lime-sulphur, gave good control in 1931, but not in 1932. The results obtained with sulphur dust appeared to depend largely on seasonal conditions. It was useful post-blossom as an adjunct to wet spraying pre-blossom, but was unreliable when used both pre- and post-blossom. It was very effective against Apple Mildew and also controlled Red Spider. Extra post-blossom dustings, as *protective agents*, were beneficial in the generally wet Summer of 1931, and normally it would be advisable, where dusting is practised, to make more applications than would be made where spraying is relied upon. In any case, the assembled data, when read in the light of prevailing seasonal conditions and the time of Scab-infection, all point to the inference that, for dusting to be most effective, it is highly desirable to make applications in advance of infection. Lime-sulphur was the best fungicide (at the strengths used) of those tested ; it gave good control of Red Spider and of Apple Mildew as well as of Apple Scab. With gelatine it was, on the whole, less satisfactory against Scab.

Fruit-drop resulted in 1932, but not in 1931, from post-blossom use of the lime-sulphur and of sulphur dust.

The influence of rootstock on Scab-infection on leaves and fruits was noted. Some evidence was obtained that Cox trees worked on certain stocks might be more easily protected by spraying or dusting than those on other stocks.

Severe fruit-russeting was caused in 1932. This is regarded as the result of interaction on the trees, pre-blossom, of soft soap with lead-arsenate (or its derivatives).

Certain results are used to illustrate the cumulative effect of treatment in former trials on the same trees.

WORMALD, H. " Notes on Plant Diseases in 1933." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 142-6.

WORMALD, H. " Bacterial Diseases of Stone Fruit Trees in Britain. V. Some Field Observations and Experiments on Plum Bacterial Canker." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 147-53.

BERKELEY, G. H. " Strawberry Root Rot." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 154-5.

MOORE, M. H. " A Field Spraying Trial of Combined Fungicide-contact Insecticide Sprays in 1933. A Progress Report." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 156-65.

MOORE, M. H. " Some Field Observations on Apple Canker (*Nectria galligena*)." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 166-75.

WORMALD, H. " Brown Rot Fungi—Recent Observations on Their Incidence." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 250-5.

WORMALD, H. " Intumescences on Vine Leaves." Gardeners' Chronicle (May 19th, 1934). No. 2473, **95,** 332-3.

SUMMARY.

Vine leaves sent in for examination showed what appeared to be a yellowish powder on the underside, accompanied sometimes by a yellowish blotchy discoloration on the upper surface. This " powder " consisted of numerous pimple-like swellings about one-fiftieth of an inch in diameter ; these outgrowths, or intumescences, are not caused by any parasite but arise when the intake of water by the roots is in excess of that lost by transpiration from the leaves. Such a condition occurs when the atmosphere of the greenhouse is kept too moist or when the roots are too active, as would result in a moist warm soil. The remedy is to increase ventilation and to avoid overheating the soil.

BERKELEY, G. H. and LAUDER-THOMSON, I. " Root Rots of Strawberry in Britain. The ' Black Lesion ' type of Strawberry Root Rot." Journ. of Pom. and Hort. Sci. (October, 1934). **12,** 222-46.

SUMMARY.

The investigations reported herein are concerned with root rots of strawberry, of the " black lesion " type as found in Hampshire, Somerset, Sussex, Wiltshire, Dorset, Kent, Gloucester, and Surrey, England. This type of root rot appears to be distinct from the " red-core " type as found in Lanarkshire, Scotland, and it is widely distributed in Europe and America. According to the literature " root rots " are considered to be of major importance in connection with the general deterioration of strawberry plantations.

A large number of isolations were made from diseased roots, and fungi of the following genera were isolated : *Coniothyrium, Hainesia, Cylindrocarpon, Fusarium,*

Pachybasium, *Phoma*, *Botrytis*, *Chalaropsis*, *Rhizopus*, *Penicillium*, *Verticillium*, *Sphaeropsis*, *Cephalothecium*, *Rhizoctonia* (orchid type), *Pythium* and other Phycomycetes, and an unidentified sterile fungus. Nematodes were found in the fine roots on a few occasions. Technique used in connection with isolations and with tests for pathogenicity is outlined.

As a result of inoculation studies, five fungi have been found to be capable of parasitizing strawberry roots, namely, *Coniothyrium Fuckelii* Sacc., *Hainesia Lythri* (Desm.) v. Höhn, *Cylindrocarpon radicicola* Wr., *Fusarium orthoceras* App. and Wr., and *Pachybasium candidum* Sacc. Accordingly five root rot diseases are recorded for the strawberry, though the symptoms of all five are very much alike, if not identical. Under field conditions any one or all of these diseases may be present in a plantation. A healthy virus-free, insect-free clone of Royal Sovereign was used in connection with all inoculation tests and therefore the possibility of " virus " or " insects " aiding the root rot fungi has been eliminated.

The symptoms for all five diseases comprise dwarfing and stunting of leaves and petioles and browning and drying of lower leaves, resulting in a flat type of plant. Plants severely attacked wilt and die. The roots of affected plants show (1) lack of fibre, (2) distinct black lesions on roots (white to yellow brown in colour), and (3) dead roots. The roots of " root rotted " plants are noticeably deficient in fibre.

The nature and sequence of attack appears to be associated primarily against the finer and younger roots. In the spring the first symptoms are apparent on roots formed the previous autumn, followed later by attack against roots formed in the current season. A reaction on the part of the host plant to " throw off " the fungus is indicated by the laying down of cork cells in affected areas.

The detrimental effect of root rots is illustrated by describing in detail the result of root rot attack in two plantations at East Malling.

A comparison of runner plants from a healthy clone, and a yellow-edge clone of Royal Sovereign showed that the roots of both sets of plants were equally healthy. Therefore yellow-edge in its first season at least has no detrimental effect on the root-system.

It is contended that the root rots described herein play a major rôle in the general degeneration of the strawberry because of the almost constant " root pruning " to which attacked plants are subject.

Control measures at the present time consist in (1) selection of runner plants free from " black roots " and (2) crop rotation. A resistant variety offers the best means of control for a disease of this kind.

WORMALD, H. " The Development of Scab in Stored Apples." Journ. Min. Agric. (September, 1934). No. 6, **41**, 551-5.

SUMMARY.

Scab spots may appear during storage on apples that are apparently quite sound at the time they are picked.

These storage Scab spots are different from the ordinary Scab spots seen on fruit before storage, in their absence of cork, and in the sunken, saucer-shaped form and shiny black colour of the larger spots; the smaller spots are more superficial and usually lobed.

The larger spots may produce pustules bearing spores.

To avoid Storage Scab, routine spraying must be a regular practice, and if necessary a late application of a fungicide must be made. Apples should not be stored when they are wet.

ENTOMOLOGY

Observations on the Life-Cycle of the Fruit Tree Red Spider.

Investigations were commenced to determine the correlation of the hatching period of the nymphs of the fruit tree red spider from their winter eggs, in relation to the blossom period of apples and plums.

On certain varieties of apples it was found that a majority of the nymphs had hatched by petal fall, and since summer eggs were not laid until about a week later, a whole week elapsed when the egg stage was not present at all.

It was observed that only a small percentage of the mites had hatched from their winter eggs when certain varieties of apples were in the " pink-bud " stage, a factor which might reasonably account for the failure of the pre-blossom lime-sulphur scab sprays to control the mite in 1934, since it is known that the lime-sulphur spray does not effect the egg. (R.M.G. and A.M.M.)

Resistance of Apple Seedlings to Woolly Aphis Attack.

During 1934, 1,015 seedlings were tested for immunity to Woolly Aphis. 455, of which 243 were raised by Mr. M. B. Crane, of the John Innes Horticultural Institution, Merton, had already survived inoculation with aphides for one year. Of these, 278 remained immune and were handed over to the Propagation Section for pomological tests. The highest degree of immunity was found in the group Long Ashton OF5 × Northern Spy 46·7 per cent. immune. Northern Spy × Zuccalmaglio Reinette gave 40 per cent. immune seedlings.

Of the 560 one-year-old seedlings tested, 243 remained resistant and will be tested for a further year.

The following young trees were also tested :

Curtland	three trees	all susceptible.
Early McIntosh	two trees	susceptible.
Alsopps Early	two trees	susceptible.
Kirk's	one susceptible	one resistant.
Lady Carrington	two trees	immune.
Macoun	three trees	immune.
Red Spy	five trees	immune.

(R.M.G. and A.M.M.)

Causes of Immunity.

Work has progressed along lines similar to those followed last year. The results obtained showed that the cause of immunity or susceptibility is not extracted except in small amount by alcohol, ether or boiling water and that after successive extractions with these three solvents most of it remains in the residue. They also suggest that it is amongst compounds of the cellulose-pectin type that the " cause " must be sought.

(R.M.G., A.M.M. and W.A.R.)

Apple Sawfly.

Field spraying and dusting trials carried out in 1934 confirmed the previous season's findings (D97 and D99) with regard to the vulnerability of the several stages of the pest. An account of these trials is being prepared for publication as a progress report. (W.S. and F.J.D.T.)

Apple Blossom Weevil.

Tests of dusts as a means of preventing oviposition were continued. Although a Derris dust again (see D94) gave promising results, it was clear that weather conditions impose a limit to the degree of control which can be obtained with it. A barium silicofluoride dust was ineffective. (W.S. and F.J.D.T.)

Impregnation of Corrugated Cardboard Bands.

Investigations were continued to ascertain whether the Apple Blossom Weevil and the Codlin Moth larva can be induced to shelter in chemically treated corrugated cardboard bands, which will in time destroy them.

One treatment actually appears to be an attractant to the weevil, since double the number were present in the bands of this treatment, as compared with those contained in the control bands. Other treatments also proved to be very promising, therefore it is proposed to continue the experiment on a field scale next year. None of the treatments caused any injury to the trunks of the trees, and the destruction frequently caused to the bands by birds and mice proved to be negligible.

A progress report has been prepared. (R.M.G., A.M.M. and F.J.D.T.)

Apple Fruit Tortricids.

Further observations have been made on the life-cycle of the apple surface eating fruit tortricid (*Cacoecia podana* Scop.). Under natural conditions the oviposition period extends throughout the month of June. The larvae were noted to hatch from the egg masses which are deposited on the upper surfaces of the leaves, from the 18th June until 7th July.

Several other species of tortricids were also noted to be common in the Spring, and at least two species may prove to be equally important as *C. podana* Scop. The life-cycles of these species are under investigation. (A.M.M.)

Tests of Derris and barium silicofluoride sprays and dusts were carried out and (in the case of Derris at any rate) showed sufficient promise to justify further trials. (W.S. and F.J.D.T.)

Systematic Study of Gall Mites.

A systematic study of gall mites which infest plants is being continued, and material has been received from Great Britain, South India, United States of America, and the Sudan. Several species have not yet been described. The English species proves to be a new one. It is contained in the family *Callyntrotus*, which hitherto had not been represented in this country. (A.M.M.)

Tarsonemid Mites.

A collection of species of mites of the genus Tarsonemus which infest cultivated plants is being made, and material has been received from Great Britain, Canada, U.S.A., and the Sudan. It is proposed to study the group in detail when sufficient material is available. (A.M.M.)

The Strawberry Tarsonemid Mite.

Further investigations upon the control of the strawberry tarsonemid mite have been carried out, the details of which have been published (D91). The migratory habits of the mites are being studied, and it has been found that runner plants, which have been rendered mite free by the warm water treatment, become infested again in the first year of planting if they are planted adjacent to an existing mite infested field. It is desirable to isolate young plants, therefore, in order to keep them mite free.

Investigations on the control of the strawberry tarsonemid mite have been continued.

Further modifications in the practice of the warm water treatment have been made, and it has been found that the success of the treatment depends largely upon the weather conditions at the time of planting. (A.M.M.)

Strawberry "Yellow-Edge" Disease.

Experiments have been continued to determine whether the strawberry aphis (*C. fragariae* Theo.) and the strawberry tarsonemid mite (*T. fragariae* Zimm.) are vectors of the virus. This season's work proves conclusively that the strawberry aphis is a vector of the virus. Experiments with the strawberry tarsonemid mite have given negative results.

In view of the importance of the aphis, a study of its life-cycle is being investigated. Under glasshouse conditions five alternative host plants have been found, but the aphis has not been recorded from these hosts in the field.

Experiments on the control of the aphis are also being investigated.

During the year a general review of the damage done by insects and mites to strawberry plants was undertaken (T.C.5). (A.M.M.)

Blackberry Mites.

A study is being made upon certain mites which occur on cultivated blackberries and closely allied plants. The possible association of mites with the condition of the ripening fruits described as Redberry disease is also being made. (A.M.M.)

Raspberry and Loganberry Beetle.

In a trial carried out on raspberries, Derris dusts were somewhat less efficient than Derris and soap as a means of control.

A preliminary trial was carried out on loganberries in collaboration with the Mycology Section with the object of controlling both Loganberry Beetle and Cane Spot with a combination spray containing Derris. A good control of the beetle and a measurable degree of control of Cane Spot were obtained.

Small scale trials confirmed last season's finding (D98) that the pest can be controlled on blackberries by a single spraying of Derris and soap. (W.S.)

Raspberry Shoot Moth.

Experiments carried out in 1933-1934 showed that a complete control of this pest can be obtained, at the sacrifice of a year's crop, by cutting down the fruiting cane in the Spring. (W.S.)

DERRIS.

The main field trials of Derris are referred to above in connection with Apple Sawfly, Apple Blossom Weevil, Apple Tortricids and Raspberry Beetle. Valuable help in connection with the chemical evaluation of the Derris used was received from Dr. Tattersfield, of the Rothamsted Department of Insecticides. Work on the correlation of the toxicity of Derris with its chemical properties has been continued in collaboration with Dr. Tattersfield. (W.S.)

THE TESTING OF INSECTICIDES.

Methods have been worked out for the laboratory testing of potential insecticides and spray auxiliaries. The phytocidal effect of the more promising of the materials so tested has been studied in the field by methods worked out during the past two seasons. (W.S. and F.J.D.T.)

PUBLICATIONS DURING THE YEAR.

MASSEE, A. M. "The Degeneration of the Strawberry. IV. The Insects and Other Animals associated with Degeneration of the Strawberry." Imp. Bur. Fr. Prod. Tech. Comm. No. 5 (February, 1934). 20-8.

SUMMARY.

A resumé is given of the literature of insects and other animals which attack the strawberry.

The paper is divided into four sections which are as follows:

(1) The Association of Eelworm with Strawberry Degeneration;
(2) The Association of Aphides with Strawberry Degeneration;
(3) The Association of Mites with Strawberry Degeneration, and
(4) The Association of Insects and Mites with Virus Disease of Strawberry.

The Bibliography contains forty-one references.

MASSEE, A. M. "Notes on Mite and Insect Pests for the year 1933." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 176-80.

MASSEE, A. M. "Investigations on the Control of the Strawberry Tarsonemid Mite." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 181-7.

STEER, W. "Studies on *Byturus tomentosus* Fabr. IV. 1933 Experiments on the Control of the Raspberry and Loganberry Beetle." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 188-96.

HEY, G. L. and STEER, W. "Experiments on the Control of the Apple Sawfly (*Hoplocampa testudinea* Klug.) The Results of One Season's Field Trials and Some Considerations arising from them." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 197-216.

HEY, G. L., MASSEE, A. M. and STEER, W. "An Experiment on the Control of the Apple Blossom Weevil (*Anthonomus pomorum* (L.) Curt.) by means of a Derris dust." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 217-19.

GREENSLADE, R. M., MASSEE, A. M. and ROACH, W. A. "A Progress Report on the Causes of Immunity to the Apple Woolly Aphis (*Eriosoma lanigerum* Hausmann)." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 220-4.

GREENSLADE, R. M. and MASSEE, A. M. "Some Notes on the Woolly Aphis Parasite (*Aphelinus mali* Hald.)." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 225-7.

HEY, G. L. and MASSEE, A. M. "Tortrix Investigations in 1933." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 228-30.

HEY, G. L. and MASSEE, A. M. "Observations on the Effects of various Gas Mixtures of known composition on Tortrix Larvae in Store." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 231-3.

HEY, G. L. and STEER, W. "Miscellaneous Observations on Apple Sawfly (*Hoplocampa testudinea* Klug.) in 1933." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 234-42.

MASSEE, A. M. "The Warm Water Treatment of Strawberry Plants." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 256-7.

HEY, G. L., MOORE, M. H. and STEER, W. "Apple Sawfly—Some Suggestions for Control Measures." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 258.

HEY, G. L. and THOMAS, F. J. D. "On the Biology of some Tortricidae (Lepidoptera) infesting Fruit Trees in Britain. I. *Cacoecia* (*Tortrix*) *podana* Scop." Journ. of Pom. and Hort. Sci. (December, 1934). No. 4, **12**, 293-310.

SUMMARY.

An account has been given of the life history and habits of the moth, *Cacoecia podana* Scop.

The egg and egg laying have been described and the morphology (excluding the chaetotaxy) and biology of the larva and pupa have been studied.

The measurement of the larval head capsule in relation to Dyar's Hypothesis has been discussed.

The damage done by the larva to fruit trees and other host plants, and to apple fruits in store, has been described.

The effect on the larva of routine control measures has been observed.

The parasitism of the moth has been studied ; one Dipterous and seven Hymenopterous species of parasites have been bred out.

HOPS

Cultural Trials.

A progress report of the training and distance trial with the seedling L21 has been published (B23). The data so far obtained show that the yield per acre is greatly increased by closer planting, though the yield per hill is increased by wider spacing. The number of bines per string has had less effect on the cropping than the distance between the hills, but two bines per string has given heavier crops than one bine per string. The size of the cones and consequent quality of the crop may be materially affected by the treatments in certain seasons.

The experimental plot of the seedling OP21, which has now been named " Brewers' Favourite ", has had the crop recorded for the first time. Owing to adverse weather conditions in the early Summer and consequent scarcity of bine, the differential pulling treatments were not put into operation. The results obtained from the two distances of planting were, however, significantly in favour of closer spacing.

The trials with Fuggles (three strains and severity of cutting) and the seedling OV7 (number of bines per string) were not sufficiently established for crop records to be taken.

Sufficient material is now available for planting trial plots of the seedlings P13 (distance and pulling) and OO63 (time of cutting and pulling).

Distribution of New Varieties.

Favourable reports have been received of the two experimental half acres of Brewers' Favourite (OP21) planted on farms in the Kentish Weald and Herefordshire last season. The variety appears to have had fewer failures, and to have withstood the drought better than Fuggles on the same land.

This season over 6,000 sets of Brewers' Favourite are being distributed to growers.

New Seedlings.

Ten varieties have been grubbed and their place taken by twelve new seedlings. The crop from 250 seedlings was dried separately for cropping records, and bottle samples of the dried hops for analysis were taken from ninety-seven varieties. The crop from fifty seedlings was pressed separately in part pockets for use in brewing trials.

The analysis of the 1932 crop again proved C9a, which has been named " Brewers' Gold ", to have a greater preservative value than any other hop, English or foreign.

Among the mid-season varieties, eight were higher in preservative value than the highest commercial variety (Fuggles). In the late hops thirty-seven varieties exceeded the best commercial variety (Canterbury Golding), one of which was " Brewers' Favourite " (see above). Another late variety which appears to have a commercial future is OO63, with the very high preservative value of 12·18 and has proved to be suitable for brewing Pale Ales.

Among the others are several varieties of the Manitoba and New Mexican class which are very heavy croppers and are suitable for Stouts, with a preservative value equal to or exceeding the best American hops.

This work has been carried out in collaboration with Professor E. S. Salmon, the raiser of the new seedling varieties, who has published a report (B24), and Mr. A. H. Burgess, of the South-Eastern Agricultural College, Wye, who undertakes the analyses.

(F.H.B. and J.A.)

PUBLICATIONS DURING THE YEAR.

BEARD, F. H. "Cultural Trials with Hops. I. The Effect of Distance of Planting and Number of Bines per String—A Progress Report." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934). 132-6.

SALMON, PROFESSOR E. S. "Seventeenth Report of the Trial of New Varieties of Hops, 1933." E. Malling Research Station, Kent. August, 1934.

BEARD, F. H. "The Story of Hops in Kent." Kent County Journal (Christmas, 1934). No. 6, **2,** 18-20.

SUMMARY.

This article gives an outline in popular form of the hop growing industry in Kent from earliest times to the present date.

The reasons for Kent becoming the chief centre of the industry in England are briefly discussed, the manurial requirements of the crop and methods of training, disease control are also dealt with. Reference is made to the experimental work now in progress at East Malling Research Station and Wye College, and to the improved modern kilns for drying.

Section III

PRELIMINARY RESEARCH REPORTS

POMOLOGY

ROOTSTOCKS FOR PEARS*

By R. G. HATTON

It is just twenty years since investigations upon rootstocks for Pears were initiated at East Malling. But since tradition has always emphasized that "He who plants Pears plants for his heirs," it is not surprising that many of the questions which it was then planned to try to answer still remain only partially solved.

The knowledge so far accumulated has at least taught that it is impossible even to generalize about Pears on the Quince and the Free (or seedling) Pear roots, so glibly referred to by horticultural writers of the seventeenth and eighteenth centuries.

Quince Rootstocks.

An examination of collections of Quince stocks in commercial circulation amongst representative European nurserymen showed that there were at least four varieties of Quince, readily distinguishable in spring and summer by their early foliage colour, leaf shape and general habit of growth. These features were described in detail and illustrated in 1920 (1). Unfortunately, it had to be reported that these four varieties were often intermixed, and that there was neither uniformity in naming nor universal agreement as to which was the true Angers, Common or de Fontenay Quince. There appeared to be, in addition, a number of slightly variant types (possibly seedlings) intermixed with these four predominating varieties, but, since they were only found in insignificant numbers, the actual multiplication and testing was confined to Types A, B, C and D as these clonal selections were designated, so as to avoid controversy over their nomenclature. The Portugal Quince, frequently recommended by early writers as more vigorous than other varieties of Quince and therefore the best for delicate Pears, no longer appeared to be in use as a rootstock. However, the Portugal Quince of the twentieth century was procured and added to the other four as Type E for testing—with what results will be seen later.

There are now available for examination and analysis the individual tree records for cropping and certain expressions of growths on seven varieties of Pear budded upon this series of Quince rootstocks. In all, between four and five hundred trees have been under observation, and it is proposed to summarize and bring up to date the preliminary conclusions published in 1928 (2), when it became apparent that there was a considerable range of vigour and cropping habit exhibited upon any variety budded upon these five Quinces.

* Account prepared for Royal Horticultural Society Fruit Conference, September, 1934, and reprinted here by permission of the Royal Horticultural Society.

Free Pear Stocks.

Before so doing, it is convenient to compare the existing knowledge with regard to the Free Pear stock and to refer to the generally accepted contrast between trees on Pear and on Quince roots. A report on this aspect of the investigations has recently been issued (3). Examination of a number of typical samples of the seedling Pear rootstocks of Europe showed them to be so varied botanically as to suggest that four more or less distinct species might be involved. Representatives of the range of variation within these "species" groups, called, for the purpose of the pomological experiments in view, Free Pear A to D, were described and classified from their foliage and growth characters, and some thirteen individuals were successfully multiplied by layering methods (some much more easily than others)—in order to build up clonal races for trials as rootstocks. These were initially budded with Dr. Jules Guyot, chosen because of its traditional suitability for and free cropping habit upon Pear stock. Two of the selected families of Pear rootstocks proved "incompatible" to this variety after one year in the nursery, but there are now over 250 trees—half standards and bush—established and, in the main, flourishing upon vegetatively raised Pear stocks. See Fig. 1. Individual tree records of growth and cropping have now been made for six years. Striking significant differences in vigour have been found; trees on some series making twice the growth of others. Although these trees on different Pear roots have as yet borne practically no fruit, there are equally striking differences apparent in the number of fruit buds formed and the place where they are borne. These facts and the following figures suggest that whilst some Pear stocks may delay cropping, others may be expected to encourage early fruiting.

Table I.*

Comparison of Vigour and Cropping of Ten-Year-Old Dr. Jules Guyot on Representatives of one Group of Layered Free Pear Stocks.

Free Pear Stock.	No. of Trees.	Total Wood Growth in Metres.	Cross Section of Stem. Sq. cms.	Fruit Buds.	Fruit.	
					No.	lbs.
C_7	10	183	39	384	9	2·3
C_2	16	183	44	518	21	5·4
C_1	15	166	39	325	3	0·5
C_8	10	92	25	474	4	0·8
C_4	10	87	22	320	2	0·5

Trees on "Quince" and "Pear"—A Comparison.

Now that this range of vigour and fruit bud formation has been proved to exist amongst standardized races of Pear stocks, it would be unwise to adhere too literally to the accepted generalization that whilst trees on Pear stock are vigorous and slow to crop, those on Quince are dwarf and comparatively quick cropping. Whilst this is probably undoubtedly true in the vast number of possible comparisons, there is now sufficient evidence to encourage the hope that one day it may be possible to produce a range of clonal Pear rootstocks. This would obviate the very striking disadvantages

* Although the crops are still small the fruits harvested during the two subsequent seasons confirm these results.

to the general use of Quince rootstocks in the nursery, where many combinations are known to be "incompatible" which involves the expensive process of "double-working", and in the plantation, where certain varieties are all too prone to establish themselves on their own roots in preference to remaining on their original rootstock.

The writer is not aware of the existence of any satisfactory data from which to compare the growth and cropping of different varieties on selected Pear and Quince roots. When the comparative tests of Pears on Quince were planted at East Malling, there was an insufficient number of vegetatively raised Pear rootstocks to allow of their inclusion. Unhappily, when these Pear rootstocks became available and the first trial was laid out, the scion variety chosen, Dr. Jules Guyot, has proved so incompatible to the Quince stocks included for comparison that no trees on Quince roots are now surviving. As it will therefore be a number of years before such a comparative trial can be accomplished—trees are available on two varieties of layered Pear and Quince for the first time this autumn—it is thought worth referring to the small trial at East Malling (now twelve years old) in which trees on graded seedlings were planted out for comparison with similar varieties on known Quince roots. The one-year seedling Pear stocks were graded according to their "species" group—"Free Pear" A, B or C. These were planted out in the nursery with layers of Quinces A and B and budded with Pitmaston Duchess, Emile d'Heyst and Durondeau. The number of trees ultimately available for planting out on these graded seedlings was very small and so does not permit of too serious comparison. The sets of trees varied from units of only four up to ten plants of each variety upon each seedling group. However, there are certain general points very easy for the eye to observe, and which figures do not belie, where the facts are susceptible of numerical expression. A much darker green foliage is apparent throughout upon the trees on Pear roots. In the case of Pitmaston Duchess and Emile d'Heyst, the trees on Pear roots are outstandingly more vigorous, but with the exception of one notable tree, this is not so in the case of Durondeau. This is not only borne out by measurements of wood growth to the end of 1926 (6 years) and of height and spread (10 years), but is also confirmed by stem measurements at the present day :—

TABLE II.

COMPARISON OF TWELVE-YEAR-OLD TREES* ON QUINCE AND "GROUPED" SEEDLING PEAR ROOTS.

Mean Area in Square Cms. of Cross Section of Stem, April, 1934.

	Quince.		Pear.		
	A.	B.	A.	B.	C.
Pitmaston Duchess	89 (13)	—	135 (4)	123 (5)	127 (4)
Emile d'Heyst..	—	68 (13)	129 (9)	131 (10)	138 (7)
Durondeau	—	61 (13)	57 (4)	72 (7)	98 (1)

Whilst it is not possible owing to the variability of the trees on Pear roots to detect differences between the different seedling groups, the comparisons between these and the trees on Quince are certainly valid. They suggest that the varietal factor must cut across any generalization as to comparisons of growth on Pear and Quince.

* The number of trees is the figure in brackets.

The very exceptional tree of Durondeau on Pear Seedling C—as well as a study of the individual records of other trees on these seedlings—emphasizes that the varietal factor in the rootstock plays no less a part in qualifying any general statement.

One further general fact calls for notice in the records of cropping as shown below :—

TABLE III.

COMPARISON OF TWELVE-YEAR-OLD TREES* ON QUINCE AND "GROUPED" SEEDLING PEAR ROOTS.

Mean Crop in lbs. per Tree to End of 1933.

	Quince.		Pear.		
	A.	B.	A.	B.	C.
Pitmaston Duchess	15 (13)	—	4 (4)	10 (5)	6 (4)
Durondeau	—	70 (13)	9 (4)	18 (7)	4 (1)
Emile d'Heyst..	—	83 (13)	70 (9)	57 (10)	114 (7)

Whilst differential cropping in favour of the trees on Quince is almost certainly significant in the case of the first two in the table, it does not appear so by 1933 in the case of Emile d'Heyst, which showed big differences in comparative size of trees on Quince and Pear. In fact this is mainly due to the "good behaviour" of individual trees. Durondeau on the other hand, which at present shows little difference in tree size—even though it shows striking differences in general character and habit—shows the biggest differences in cropping to date. Though it is true that the trees on Quince A and B generally have cropped earlier and more consistently than those on the Pear seedlings, there is at least evidence that with some varieties Pear roots may not lead to excessive vigour or undue delay in cropping. There the matter must rest for some time to come, whilst further selections and trials are made of Pear rootstocks from trees of good record.

INFLUENCE OF DIFFERENT QUINCE ROOTSTOCKS.

In view of the very complete details which were given of the objects, method and nature of these trials in 1928 (2), these can now be very briefly summarized before the measurements and weights are brought up to date and discussed.

Collections of the four varieties of Quince in commercial circulation (A, B, C and D), together with the "Portugal", "Apple" and "Pear" shaped (E, F and G), after being rogued of any apparent admixtures, were further propagated vegetatively and stem-budded with seven commercial varieties of Pear. Between February, 1921, and December, 1923, some 750 trees were planted out in permanent position for detailed observation, whilst a good many more had given very definite indications in the nursery.

(*a*) *Suitability in the Nursery.*

Later results only go to confirm the four years consecutive nursery trials already reported. Of the seven Quince varieties tested only A, B and C are worthy of further consideration from the nurserymen's or fruitgrowers' point of view. The common variety D, together with the named varieties E, F and G, has exhibited a very general

* The number of trees is the figure in brackets.

incompatibility both at the end of one year in the nursery and in a delayed form subsequently in the plantation. In the few cases in which any number of trees have survived on Quince D, mostly with Conference, Fertility and Pitmaston Duchess, these trees have been so variable in growth and disappointing in cropping that they are not worth planting. The incompatibility has manifested itself in slightly different forms in different seasons and with different varieties, a poor "take" of buds and frailty of the unions, with Durondeau and Dr. Jules Guyot in 1920-1, and with Conference, Fertility and Emile d'Heyst in addition in 1922-3; small maiden trees as in the case of Pitmaston Duchess in 1920-1, and of Conference in 1919-20. There has been no sign of the incompatibility of any of the seven scion varieties used with Quinces A, B and C. There has rarely been any significant difference in the height or weight or union of the maiden trees.

(*b*) *Delayed Incompatibility in the Plantation.*

On the unsatisfactory rootstocks a high percentage of even apparently healthy maidens have subsequently died. In the first series of Conference trees, only nine on D out of an original sixteen survive to-day. These died over a period of seven years. In the second trial with the same variety, planted a year later, two trees are dead and six more very poor, out of sixteen trees on D. In a similar trial of Fertility, one tree on D has now died and a further five have never grown, out of a total of twenty trees. Three out of eight trees of Doyenne du Comice on this stock had died within four years of planting. In other cases, where the original trees have survived and eventually grown strongly, they have only too often established themselves on their own roots, as will be shown later. See Figs. 6, 7 and 8. The record of the trees on E, F and G is for the most part even worse. No such story of the progressive evidences of incompatibility can be told of trees on Quince A, B or C, with the possible exception of Dr. Jules Guyot (which does not appear really normal on any of the Quince roots), and three trees in the first series of Conference on A which are considerably more dwarfed than the rest and, as reference to the cropping records shows, started earlier into fruiting. These trees have neither the poor foliage nor unthrifty appearance of the incompatible trees already referred to, nor does a position factor appear to explain their character. It is intended one day to examine the union between stock and scion, and to investigate whether some "fault" is a possible explanation of their exceptional behaviour.

(*c*) *Effect of Quinces A, B and C on Vigour and Cropping.*

In 1928 the figures, with few exceptions, showed no significant differences in the vigour of trees on A, B and C, though the oldest trees (then 9 years) suggested that those on A and B were getting a "slight lead" over C, and it was thought that this might not be unconnected with the comparative fruiting records on these stocks to date. Actually up to the end of five years, with almost all varieties, trees on C were significantly slightly more vigorous—a valuable asset in forming a young tree quickly. At the end of this period most of the trees on C were becoming distinctly more spreading than those on A and B—another symptom of the effect of early cropping. After the first five or six years it has generally been found impossible to continue measurements of all new wood growth upon these trees and, since height and spread of tree must of necessity be rather arbitrary, the area of the cross section of the main stem (trunk) must be regarded as the most satisfactory measure of "vigour" available for comparative purposes. These calculations are here presented both when the various sets of trees were nine years old, and again when the last girth measurements were made at the end of 1933.

Table IV.

Relative Vigour of Different Pear Varieties upon Different Quince Roots shown by Area of Cross Section of Stem in Square Cm.

Variety.	Age at end of 1933.	No.	On Quince. A. End of 9 years.	A. End of 1933.	B. End of 9 years.	B. End of 1933.	C. End of 9 years.	C. End of 1933.	D. End of 9 years.	D. End of 1933.
	Years.									
Conference	14	(16)	39	79	39	84	36	67		
Conference	12	(16)	36	71	39	**78**	30	61	**23**	58
Beurre Hardy	13	(8)	75	162	**90**	195	70	**132**	None worked.	
Doyenne du Comice ..	13	(8)	49	93	**60**	122 (6)	48	**78** (7)	Only one left on Quince.	
Durondeau	13	(8)	37	66	37	66	30	**49** (4)	None left on Quince.	
Pitmaston Duchess ..	13	(8)	51 (7)	84 (7)	**68**	107 (7)	48 (3)	83 (3)	None left on Quince.	
Fertility	10	(20)	56	**62*** (2)	42	46*	41	47* (3)	61	83* (11)
Dr. Jules Guyot ..	13	(8)	20 (4)	33 (4)	15 (1)	27 (1)	14 (3)	25 (3)	None worked.	

* The last measurement was made in 1932 when the trees were ten years old.

Note.—The figure in brackets represents final number of trees not scion rooted.

With the exception of Pitmaston Duchess, Beurre Hardy and Doyenne du Comice on Quince B (and Conference on D) none of the differences at the end of nine years are significant and as the 1928 report said there was lacking "ocular demonstration to show a falling off in vigour" on Quince C. The exceptional growth of the above-mentioned varieties on B, at least in the case of Beurre Hardy and Comice seems entirely due to a positional factor. Two trees of each, outstanding in size, occur close together in one part of the plot only.

By 1933, however, the picture both in the plantations and as shown in figures is a very different one. It is now obvious that in practically every case the trees on C are the smallest. In four cases (Conference, Beurre Hardy, Doyenne du Comice and Durondeau) out of seven, the area of cross section of stem of trees on C is now significantly smaller than that of trees on A or B, and in a further case (Pitmaston Duchess) it is significantly less than that on B. The only exceptions, Fertility and Dr. Jules Guyot, as will be shown later, are of doubtful value, owing to complicating circumstances of scion rooting in the former and the small number of surviving healthy trees of the latter on any Quince roots.

Quince C, like Apple rootstocks Nos. IV and VII, has, after an initial period of both vigorous growth and cropping, apparently settled down definitely as a dwarfing stock. The questions which arise with regard to all dwarfing rootstocks naturally occur. How long will it last? Will it keep on growing? How close is it safe to plant it? At one time it was thought that "Pear and Quince" only lasted about fifteen years, but the Conference trees on Quince C at East Malling are still making some leader growth in their fifteenth year despite a drought and a heavy crop.

CROPPING.

When the 1928 progress report was issued all the varieties worked on Quince C had given the earliest fruits. See Figs. 2 and 3. The following crop weights complete the picture to date.

It will be seen that when all the sets of trees had reached nine years of age the situation is not very different. In five out of the eight comparisons, trees on C are still cropping significantly more heavily than on A or B, and in a sixth more heavily than on A. There had been practically no crops on Doyenne du Comice up to that period, but as soon as this variety began to fruit the trees on C bore most heavily. The two apparent exceptions, as in the case of vigour, were Fertility and Dr. Jules Guyot, but the true results on both these sets are again doubtful.

At the end of 1933 when the sets ranged from twelve to fourteen years old, trees on C have retained their significant lead in cropping in four out of the six valid comparisons; in the case of the oldest series of Conference and the variety Durondeau, there was no significant difference between the cropping of trees on any of the three Quince stocks. In the case of Beurre Hardy and Pitmaston Duchess, trees on B have by 1933 given significantly greater crops than on A—and this is not due to the trees of exceptional vigour in a good location already referred to, since they in actual fact have given the smallest crops on B. With the single exception of Fertility, all remaining trees on Quince D, although normal in growth, have given notably poor yields.

As in the case of the retention of vigour, these advantageous cropping figures on Quince C arouse all sorts of speculations. The trees are now definitely smaller. See Figs. 4 and 5. Will their crop diminish or remain stationary whilst those on A and B increase? Even then, in the light of the pre-eminence of these trees up to ten years or more, would it pay better to plant them more closely and so secure heavy fruiting and early crops per acre?

Table V.

Comparative Cropping of Different Pear Varieties on Different Quince Roots.

Fruit in Lbs. per Tree.

Variety.	Age at end of 1933.	No.	On Quince.							
			A.		B.		C.		D.	
			End of 9 years.	End of 1933.	End of 9 years.	End of 1933.	End of 9 years.	End of 1933.	End of 9 years.	End of 1933.
	Years.									
Conference	14	(16)	9	148	6	155	**18**	170	5	45
Conference	12	(16)	18	65	21	87† (8)	**42**	**124**	15	47 (8)
Fertility	10	(20)	67	131* (2)	64	98*(13)	50	82* (3)	53	89*
Beurre Hardy	13	(8)	2	55	4	104	**13**	**130**	None worked.	
Doyenne du Comice ..	13	(8)	4	22 (8)	0	30 (6)	2	**52** (7)	2	19 (1)
Durondeau	13	(8)	25	97	40	114	40	118 (4)	1 (?)	None left.
Pitmaston Duchess ..	13	(8)	5	32 (7)	4	64 (7)	**12**	**90** (3)	2	None left.
Dr. Jules Guyot ..	13	(8)	23	60 (4)	18	40 (1)	14	38 (3)	None worked.	

* Last crop in 1932.

† Eight trees were removed, but were not dwarfed or scion rooted.

Note.—The figure in brackets represents ultimate number of trees still on Quince roots, otherwise the numbers remain as in column 3.

The first season's crop of Conference on the fourteen-year-old series on Quinces A, B and C, shows some suggestive results. Whilst there is no significant difference between the *number* of fruits upon any of the stocks, the crop off Quince B is significantly *heavier* than off C, there being 4·6 fruits to the pound on B as against 5·5 on C. (Trees on A hold an intermediate position.)

On the younger series of Conference, the total weight and size of the fruit off B is significantly greater than off either A or C. Preliminary records of the 1934 crop from Beurre Hardy point in the same direction, the crop off A falling strikingly behind those off B and C, but this single season's cropping result is insufficient ground for recommending the use of Quince B in preference to A, though, as the comparative tables show, it has proved up to the present to be at least as valuable.

Up to this season there has been no obvious contrast to suggest an economic difference in size of fruit off the various stocks, and even now it cannot be said that the fruit off C is unduly small. However this tendency suggests that early heavy cropping, as with No. IX apple stock, may end in small fruit if cultural and manurial treatments are not specially adapted to this type of tree.

Whilst therefore the present season's heavy crop seems to show that the trees on C are not finished, time alone can answer these questions fully. However, Quince C has been notably successful in bringing into earlier bearing the more shy, and therefore more remunerative varieties of Pear such as Doyenne du Comice and Pitmaston Duchess, and this fact alone seems to justify its recommendation for commercial trial. There is little doubt that it is ideal for well-fed garden soils where even the marked dwarfing effect upon such heavy cropping varieties as Durondeau would be compensated by high feeding.

The evidence in favour of giving a preference to Quince B over Quince A for general run of vigorous bush Pears is up to the present too slight to warrant any recommendation. It appears that there may be varietal preferences—such as that of Beurre Hardy for B or Dr. Jules Guyot for A—which can only be discovered as opportunity offers. From the point of view of the tree-raiser, there is no doubt that Quince A is the most satisfactory to handle and Quince C the least, owing to their respective vigour. However, there is no doubt that the nurseryman will be prepared to supply trees on C if the grower proves the demand. There should by now be available an adequate supply of true Quince C.

Scion Rooting.

Although the phenomenon of scion rooting was recognized and indeed described in some detail in the case of Durondeau on the unsuitable Quince G roots, when the Progress Report was published in 1928, the full significance of it has only become apparent subsequently (4).

The doubtful value of the figures presented for the varieties Fertility and Dr. Jules Guyot in Tables IV and V, has already been hinted at. The reason for this will now be explained. In view of too close planting, it became necessary in 1932, when the Fertility trees were only ten years old, to remove them. It had already been recorded that some of the trees on the less compatible Quinces D—G had suddenly become exceptionally upright and vegetatively vigorous, and that this was probably due to scion rooting, but, when the series was lifted as a whole, no fewer than 41 out of 75 trees examined were found to be already scion rooted to a greater or less extent. At the time of planting the points of union between stock and scion of all the young trees in the Pear rootstock experiments had been purposely left just above ground level so as to guard against this possible contingency. Unfortunately, in the course of normal cultivations the soil

has been drawn towards the trees, which have undoubtedly "settled down" in the ground. This has enabled scion rooting to take place. Of the trees of Fertility on Quince A, 70 per cent. showed scion rooting, 35 per cent. on Quince B and 85 per cent. on Quince C. Now, in looking back over the records of cropping, it was found that as is general the set of trees on C had fruited most heavily up to the end of seven years (1929), after that date differential rootstock effect on crop becomes less apparent. Although this may partly be due to the naturally heavy bearing habit of Fertility, the main reason is obvious now that it is known that the trees had been scion rooting for some years.

An adjoining planting of young trees of Dr. Jules Guyot, Emile d'Heyst and Durondeau—which are not included in the figures presented in the tables—were also lifted and examined. Fifty out of eighty-two trees of Dr. Jules Guyot showed that the scion had rooted (See Figs. 9 and 10), this time 36 per cent. on A, 61 per cent. on B, and 86 per cent. on Quince C. Twenty-seven of forty-eight trees of Emile d'Heyst had behaved similarly—20 per cent. on A, 36 per cent. on B, 67 per cent. on C and 100 per cent. on D and E. Eleven out of thirty-six trees of Durondeau were scion rooted—10 per cent. on A, none on B and C and 100 per cent. on D and E. These facts made it essential that a very careful examination should be made of the other experimental plantings of Pears. The earth was scraped away from around the collar of every tree to facilitate an examination of the union. Roots which came from above (i.e. the scion) and from below (the rootstock), could usually easily be identified, but where there remained any doubt, the roots were left exposed for a period, and it was found possible to determine accurately by the size and appearance of the lenticels which were Pear and which Quince roots. A microscopical examination of root sections also formed a valuable final court of appeal.

It should be added that once a tree has become seriously established on the scion's roots, it is readily detected by the exceptionally upright vigorous growth, and large dark green foliage.

Although there are far more trees of Conference than of any other variety, in no single instance has a tree been found to have scion rooted, nor have any of the trees of Beurre Hardy. On the other hand, the details given below show that even on Quinces A, B and C some serious scion rooting has occurred with the other four varieties used in these investigations.

A very high proportion of all four varieties have scion rooted on the unsuitable Quinces D and E; but even on A, B and C 9 per cent. of the Doyenne du Comice, 14 per cent. of the Durondeau, 30 per cent. of the Pitmaston Duchess, and 60 per cent. of the Dr. Jules Guyot have now developed scion roots, and nearly double the number of trees on Quince C as compared with those on A and B. Thus varietial and rootstock influences are both apparent. However, the most instructive lesson to be learned from Table VI is from a comparison of the average crop weights from the scion rooted trees and those still on Quince. The very striking reduction in cropping of scion-rooted trees is notable. It is certainly true to say that most Pear plantations and probably the majority of fruit gardens are carrying no small number of these "passenger" trees as the fruitgrower has come to designate them. Compare Figs. 7 and 8. In the past he has even avoided using them as a source of bud or graft wood because of their sterility, and has regarded them as "rogues". In many cases it has been found that the Quince roots are completely dominated if not completely dead, and it remains to be seen whether these trees after a further period of years will return to normal cropping, or can be induced to do so by ring barking or other methods. Unfortunately the rank growth not infrequently seems to lead to very severe Scab infection. There is some slight evidence that if the tree has been growing normally on a compatible Quince stock, and has begun to crop to

any extent before scion rooting, the results on fruiting are less detrimental than when the variety gets away on its own roots quite early in its career or after a period of extreme dwarfingness on an incompatible rootstock. A variety such as Dr. Jules Guyot—or even a very heavy cropper such as Fertility—which naturally responds to the immediate check of a Quince rootstock, may continue to crop fairly satisfactorily when growing subsequently upon its own roots.

TABLE VI.

MEAN CROP IN LBS. OF FOUR VARIETIES ON QUINCE STOCKS AND SCION ROOTED TO 1933.

On Quince Stock.		Doyenne du Comice.		Durondeau.		Pitmaston Duchess.		Dr. Jules Guyot.	
		No. of Trees.	Crop.	No. of Trees.	Crop.	No. of Trees.	Crop.	No. of Trees.	Crop.
A	Still on Quince	8	22	8	97	7	32	4	60
	Scion rooted ..	0	—	0	—	1	7	4	31
B	Still on Quince	6	30	8	114	7	64	1	40
	Scion rooted ..	1	23	0	—	1	44	5	34
C	Still on Quince	7	52	4	118	3	90	3	38
	Scion rooted ..	1	18	3	76	5	40	3	36
D	Still on Quince	1	19	0	—	0	—	None worked.	
	Scion rooted ..	4	2	5	6	4	8	—	—
E	Still on Quince	2	7	1*	41	4	37	0	—
	Scion rooted ..	6	1	6	2	4	12	7	19

* Just starting to scion root.

There is evidence at East Malling to show that this phenomenon is by no means confined to Pear varieties upon Quince roots. Several examples have been found both on seedling Pear roots and upon some of the layered Pear stocks which proved incompatible. At one time a series of Fertility trees was raised upon rootstocks which included other forms of *Pyrus* such as the Mountain Ash (*P. Aucuparia*), the Wild Service (*P. Sorbus domestica*), and the White Beam (*P. Aria*). When this plantation was dug up at ten years old, all the trees which had survived and made any growth on these stocks were found to have established themselves on their own roots.

It appears to be very important to prevent scion rooting and that the obvious method for future plantings is twofold. The buds must be inserted higher up on the stem of the rootstock, and especial care must be taken in planting to ensure that the point of union will ultimately remain well above ground.

ACKNOWLEDGMENTS.

Mr. J. Amos has been associated with the writer throughout the conduct of these experiments, and many of the junior pomological staff have assisted in accumulating the records. Mr. T. N. Hoblyn has assembled and discussed the figures, and his staff have undertaken the necessary computations. To all those associated with the experiment the writer's best thanks and acknowledgments are due.

Summary.

1. The methods of classifying, identifying and standardizing (by vegetative propagation) Quince and Free Pear Stocks are reviewed.

2. The phenomenon of incompatibility of certain Quince and Pear stocks in the nursery is recalled.

3. The vigour and cropping of ten-year-old trees of Dr. Jules Guyot on five selected Free stocks are compared.

4. The vigour and cropping of three varieties on Quince and Seedling stocks are compared and growth characters described. Individual trees on Seedling stocks have been found to crop quickly. It is suggested that desirable Free stocks may be selected and standardized.

5. The vigour and cropping of seven varieties—from ten to fourteen years old—on various Quince stocks are detailed. The general utility of Quinces A and B are compared. After nine years nearly all trees on Quince C fell behind in vigour owing to heavy cropping which has been maintained to date. Quince D is shown to be a most undesirable rootstock.

6. The phenomenon of scion rooting, especially of trees on Quince, is described and shown to be of common occurrence. The detrimental effect on cropping is illustrated.

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(2) ——— "The Behaviour of Certain Pears on Various Quince Rootstocks." Journ. Pom. and Hort. Sci., 1928, **7,** 216-33.

(3) ——— "'Free' or Seedling Rootstocks in use for Pears: Their description, selection, vegetative propagation and preliminary testing." Journ. Pom. and Hort. Sci., 1933, **11,** 305-34.

(4) ——— and Bagenal, N. B. "Scion Rooting at East Malling Research Station." E. Malling Res. Sta. Ann. Rep. for 1933 (May, 1934), 243-6.

FIG. 1.

Three-year-old Dr. Jules Guyot from the nursery, showing typical range of vigour on selections C6, C2, C5 and C3.

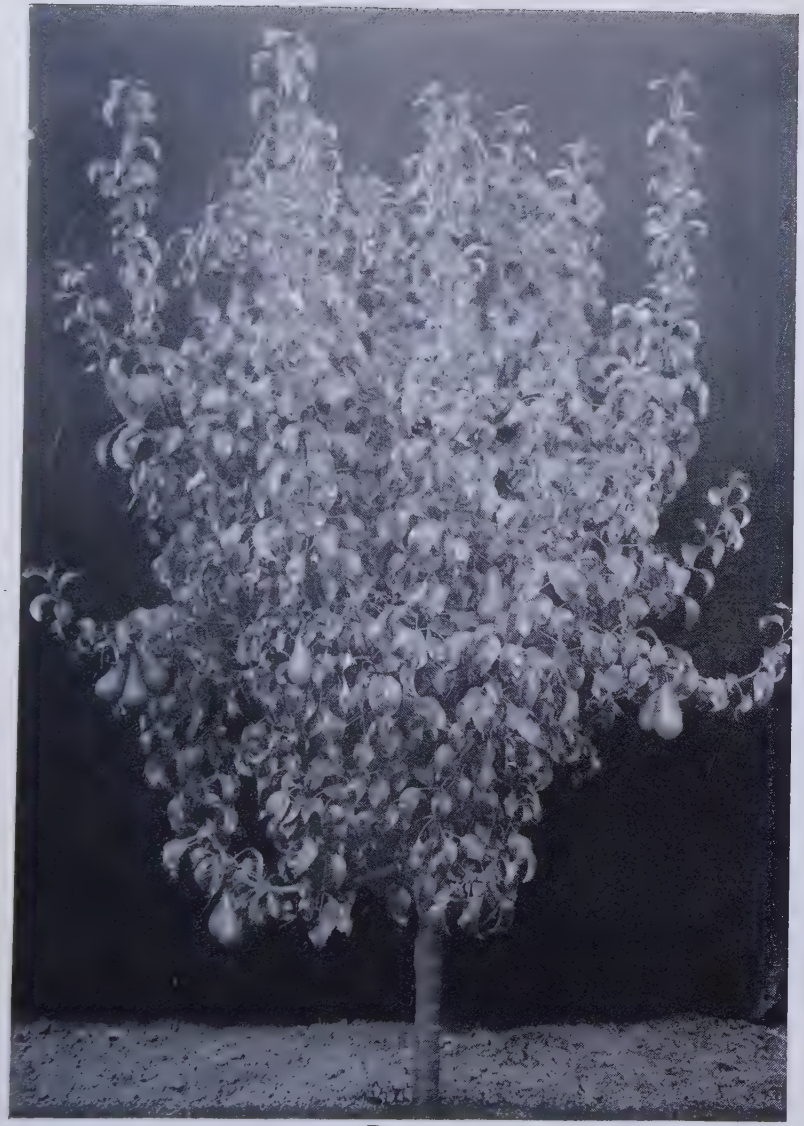

FIG. 2.
Conference Pear, seven years, on Quince A.

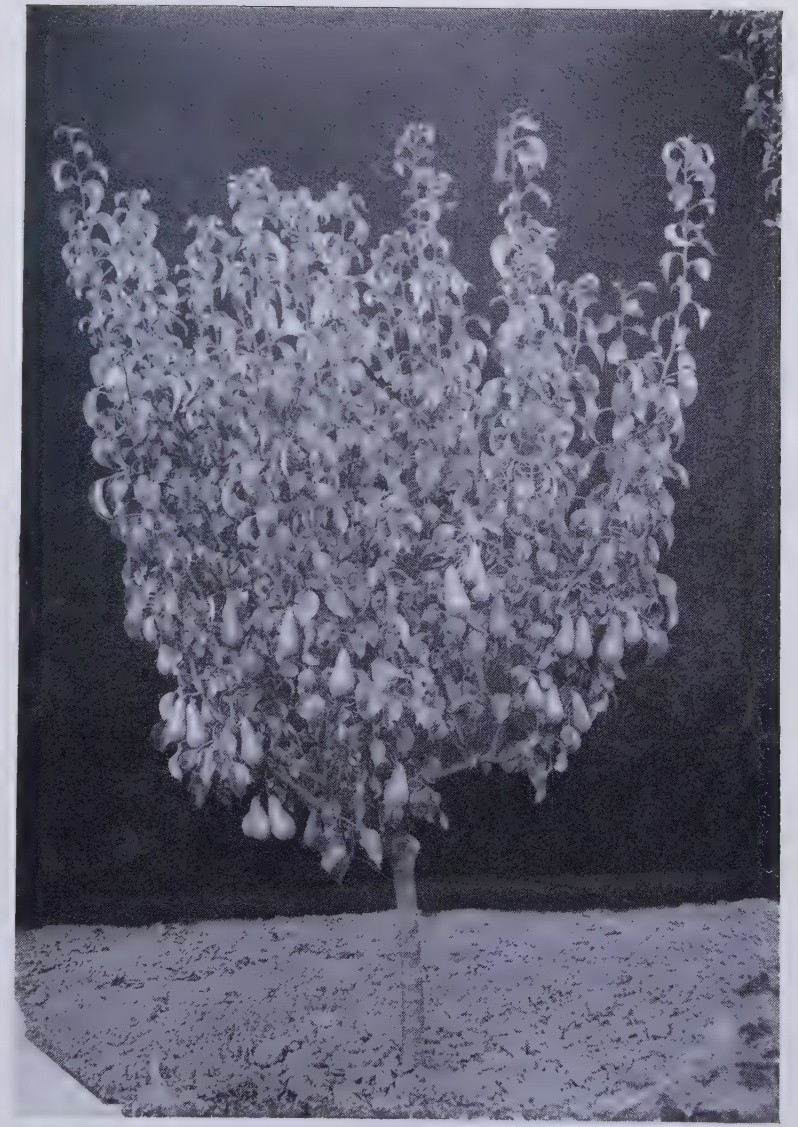

FIG. 3.
Conference Pear on C, same age. Compare fruiting and growth habit.

FIG. 4.
Thirteen-year-old Durondeau on Quince A.

FIG. 5.
Thirteen-year-old Durondeau on Quince C.

FIG. 6.
Doyenne du Comice on Quince D. Ten years old. Incompatible—not scion rooted.

FIG. 7
Doyenne du Comice on Marmot C. Ten years old. Not soon rooted.

FIG. 8.
Doyenne du Comice on Quince D. Ten years old. Incompatible on roots

FIG. 9.
Root-system of seven-year-old Dr. Jules Guyot budded on Quince—scion rooted.

FIG. 10.
Root-system of eight-year-old Pear budded on Quince—scion rooted. Original quince roots painted white.

THE ROOT-SYSTEMS OF SOME BRAMLEY'S SEEDLING APPLE TREES

By A. B. BEAKBANE and A. F. de WET

Three fifteen-year-old Bramley's Seedling apple trees on rootstocks Nos. I, II and IX were excavated during the winter of 1934-5. The land on which the trees were growing had been clean cultivated from the time of planting in January, 1920, until April, 1930, when it was laid down to grass. The soil is a medium loam of the Lower Greensand Formation overlying Kentish Ragstone, with a layer of sandy " hassock " (uncemented rock material) separating the loam and the rock. In the case of the trees on Nos. I and II the " hassock " occurred at about 100 cm. The depth of the " hassock " varied under the tree on No. IX, being at about 60 cm. directly under the centre of the tree and falling away on all sides towards the edges of the excavated area. The main object of the excavations was to discover whether the Bramley's Seedling scion had caused any modification of the root-systems as compared with the same rootstocks worked with Lane's Prince Albert, studied in previous excavations (2). A further object was to note whether the grassing down had caused any alteration in the position or structure of the root-systems.

As the trees were large and therefore the labour involved in excavating would have been very great if every root had been traced to its end, only the main portion of the root-system was excavated, a definite area of soil round the trunk being removed to a limited depth. In the case of the trees on Nos. I and II a block of soil 4 metres square, and 1 metre deep was excavated and in the case of the smaller No. IX a block 3·6 metres square and 1 metre deep. The trees were excavated by the " skeleton " method as used by Rogers and Vyvyan (1). As each root was uncovered its position and depth were marked on a plan, from which the root-systems were afterwards reconstructed and photographed (Figs. 1, 2 and 3).

Description of the Root-Systems.

The general conformation of the root-systems of all three trees was that of a horizontal scaffolding of main roots at about 30 cm. below ground level, with vertical roots descending to the rock. When the deep roots reached the " hassock " they often turned sharply and travelled for some distance along its surface.

The No. I root-system was fairly evenly distributed around the trunk. It was very fibrous and the fibre was dark-coloured and of a wavy character as can be seen in Fig. 1.* There were few roots above the 15 cm. level. Some of the deep roots turned along the rock at about 100 cm. and others continued downwards into soil pockets in the ragstone layer.

The tree on No. II (Figs. 3 and 4) proved to be particularly interesting on account of the presence of a large scion root from the Bramley. As soon as the first trench was opened 2 metres away from the trunk it was obvious that two kinds of roots were present.

* The photographs were taken with the camera 2 to 3 ft. above " ground level " plane.

In addition to some dark-coloured fangy roots with little fibre, typical of a No. II root-system, there were numbers of other finer and more fibrous roots which were of a lightish colour tinged with red and which on drying changed to a yellowish colour. These roots were of quite a different character from the No. II roots and branched in a different way. Instead of each main root dividing gradually along its length and giving off a lateral at intervals, these roots went for some distance at a uniform thickness with few lateral roots and then suddenly broke up into numbers of smaller roots all arising at about the same point (see Fig. 5). On reaching the trunk it was apparent that all these roots arose from one original scion root coming from the east side of the trunk just below ground level. Laterals from this single root spread out in all directions and almost encircled the trunk. The scion roots were very shallow, many of them being at 8 cm. or less below the grass sod, none being deeper than 22 cm., whereas comparatively few of the No. II roots were above the 15 cm. level, many fairly thick roots descending to 100 cm. and a considerable number extending vertically below this depth.

Fig. 3 shows the root-system with the scion root still attached. In Fig. 4 the scion root has been removed leaving only the fangy No. II roots. If the photographs are examined carefully it will be seen that the mass of fibrous roots, at the top right and top left hand side of Fig. 3, comes from the scion root, which can be seen emerging from the bottom right hand side of the trunk. The characteristic method of branching of the scion root as described above, can be seen on the extreme right hand side of the figure. In comparing Fig. 3 with Fig. 4 where the scion root has been cut off, it is obvious that taking away the scion root has removed most of the very shallow roots and fine roots.

The No. IX root-system was very brittle, as has been found previously. Few roots were found above the 15 cm. level. A considerable number of roots went down to 100 cm. Towards the outside of the excavated area large roots were found coming up from below; these were fairly certainly continuations of roots which passed below the one metre level nearer to the centre of the tree as seen in Fig. 2.

Table showing Height and Spread of the Bramley's Seedling Trees on three Different Rootstocks.

Stock.	Height.	Spread.	
		NE—SE.	NW—SE.
	metres.	metres.	metres.
I ..	4·4	6·8	6·7
II ..	4·6	6·7	7·0
IX ..	2·2	4·4	4·2

The general root character of the three stocks studied in these excavations is precisely similar to that found with the variety Lane's Prince Albert in the more complete excavations carried out by Rogers and Vyvyan (2). The similarity can readily be seen by comparing Figs. 1 and 4 in this paper with Figs. 1, 2 in reference (2) and the descriptions as given above with the descriptions in reference (2). These Bramley's Seedling trees were growing within 90 yards of the Lane's Prince Albert and under similar soil conditions. This comparison therefore affords an excellent opportunity

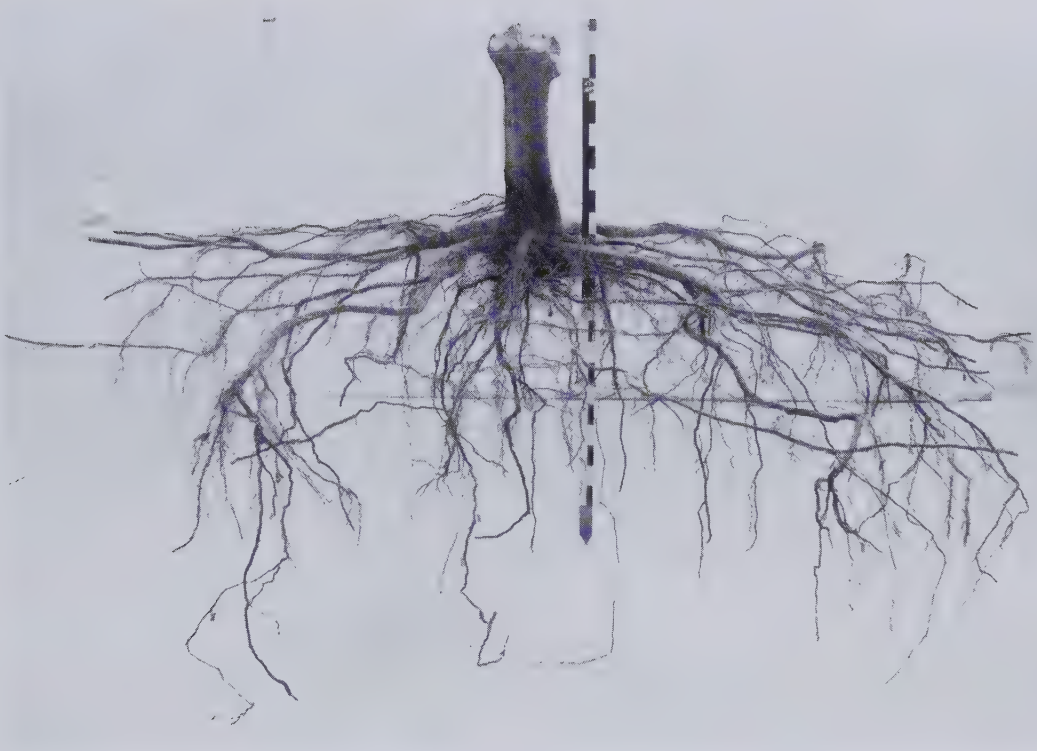

FIG. 1.
Root-system of Bramley's Seedling on No. I. Note the fibrous character of the growth.

FIG. 2.
Root-system of Bramley's Seedling on No. IX. Note the deep-rooting habit.

FIG. 3.

Root-system of Bramley's Seedling on No. II with a large scion root. The scion root begins at the right-hand side of the trunk and spreads with numerous fine branches over the whole root-system (compare Fig. 4).

FIG. 4.

The same root-system as above, but with the scion root removed. Note the fangy non-fibrous nature of the No. II root-system.

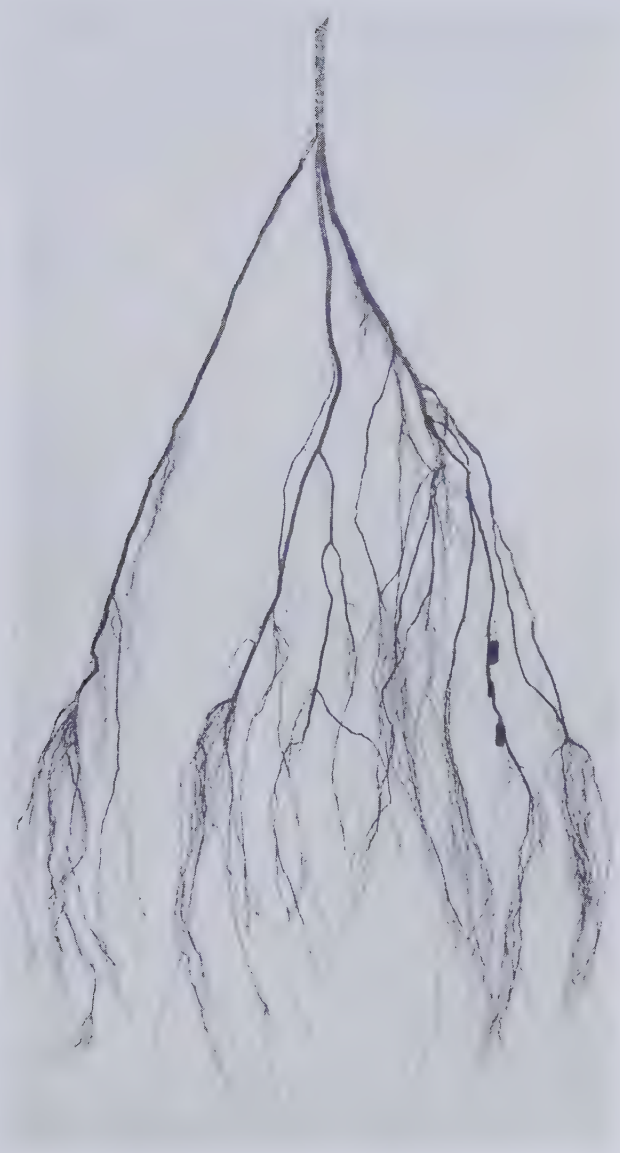

FIG. 5.

Part of scion root of Bramley's Seedling on No. II, showing the characteristic " tufted " growth.

for studying any possible scion or cultural influence upon the position and structure of the root-systems. Apart from a general increase in size of the root-systems in the Bramley trees, which is doubtless due to the greater vigour of the scion, there is no visible difference between the root-system of the two varieties on the same stocks. The grassing down of the plantation for four years does not appear to have resulted in any modification of the root-system that can be shown by this comparatively simple technique of excavation. It is clear therefore that the different rootstocks have retained their own individual characteristics throughout their life, irrespective of the scion variety worked upon them and of the cultural treatment.

Acknowledgment.

This work was carried out under the direction of Mr. W. S. Rogers, to whom the authors are greatly indebted for advice and assistance. Thanks are also due to Mr. J. Amos who took the photographs.

Summary.

Three fifteen-year-old Bramley's Seedling apple trees on rootstocks Nos. I, II and IX were excavated from a grass plot on the Lower Greensand Formation. The root-systems are described and illustrated by photographs. The presence of a large scion root on the tree on No. II rootstock is of particular interest. These root-systems showed general characteristics similar to those of the same rootstocks worked with the variety Lane's Prince Albert previously excavated from an adjoining plot.

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A COMPARISON OF THE ROOT-SYSTEMS OF MATURE TREES OF BRAMLEY'S SEEDLING AND WORCESTER PEARMAIN ON VARIOUS ROOTSTOCKS

By W. A. BANE, F. H. BEARD AND A. F. DE WET

Introduction.

The three plots with which this paper is concerned were planted in the winter of 1919-20 and consisted of stem-worked maidens of Bramley's Seedling and Worcester Pearmain planted alternately at 15 ft.

These plots were laid out to ascertain the effect of the rootstock on the performance of the scion variety, combined with a simple manurial experiment (1). With the exception of a few stocks, the number of trees worked on each was eight on plots XII and XIII and sixteen on plot XIV, planted in two positions on each plot. Plot XIV had been clean cultivated throughout, but plots XII and XIII were grassed down in 1930 and 1932 respectively.

By the spring of 1933 the trees were becoming so crowded that it was necessary to remove alternate trees. The Worcesters on plot XIII were grubbed immediately, whilst those on plot XIV were lifted for transplanting in the late winter of 1934-35. The Bramley's on plot XII were grubbed at the later date. This provided an opportunity for a fairly thorough examination and description of the root-systems for comparison with those of young unworked stocks.

Method of Lifting.

In all cases the top soil was removed and the main roots severed at 3 ft. (0·91 m.) from the trunk, except with Worcester on plot XIII where the circle was of 2 ft. (0·61 m.) radius. On plot XIV the Worcesters were lifted by hand for transplanting, whereas on the other plots a " Monkey Winch " was used.

Effect of Manuring.

With the exception of a few green crops which were ploughed in, plot XIV was unmanured for eleven years from planting. During this period the effect of this treatment was clearly shown and in 1930 remedial measures were begun. These consisted of applications of nitrogen and potash, alone and in combination, some trees being left unmanured as controls (5).

While the main root-systems of the trees were no doubt formed before the manures were first applied, it was thought possible that the amount and position of the fibre and small roots might have been affected. There was, however, no such definite result, the differences due to stock still being greater than any that could reasonably be attributed to manuring.

Effect of Pruning.

In the earlier years of plot XII the trees on one half of the plot remained unpruned, and there was some indication that these trees had fewer but larger roots. This was most marked in the case of stocks I, II and IV.

Description and Comparison of Worked and Unworked Stocks.

In the following descriptions are given firstly the characters of the young unworked stock as described by Hatton (3, 4), then those of the stock worked with Bramley's, and finally those of the same stock when worked with Worcester.

In the main the root-systems of the Worcesters on the two plots were similar, but such differences as occurred are given.

I (*Broad-leaved English Paradise*).

Young Rootstock: "The true Broad-leaf is very ready to root adventitiously, and at a more mature stage its roots seem to show a very well balanced system of fibre and coarse lateral roots at a medium depth in the soil. There are many signs that the early vigour is maintained."

Bramley's: Mainly horizontal, well balanced, roots moderate in number and of all sizes except very large, fair amount of fibre, galls on four trees.

Worcester: Horizontal, some trees one-sided, roots medium large to medium small, large amount of fibre, a few trees have one root turning down at 1'-2' from trunk.

II (*Doucin*).

Young Rootstock: "Its mature roots are characterized, in comparison with other types, by an absence of fibre. The coarse lateral roots are very strong."

Bramley's: Roots leave stock at almost all angles from horizontal to nearly vertical, rather few, bare and fangy, mainly large and medium in size, fibre and fine root almost completely absent, numerous prominent corky lenticels on roots and base of stock, medium scion roots on two trees, gall on one tree.

Worcester: Mainly horizontal, roots mostly few, medium in size, small to fair amount of fibre, a few vertical roots below or near trunk on some trees.

III (*Hollyleaved*).

Young Rootstock: "Shows much vigorous fibre, but the lateral roots are not as coarse as on I and II, and they have a very decided downward tendency in growth."

Bramley's: Horizontal, roots rather few, dark in colour, considerable fine root and fibre, particularly close to base of stock, a few corky lenticels on or near stock stem.

Worcester: Mainly horizontal, on some trees one-sided, roots mostly few, large to medium small, fair amount of fibre. On plot XIII the fibre was mostly near the trunk, whereas this was so on only one tree on plot XIV; the downward tendency of the roots, varying from slight to an angle of 45° as described for plot XIII was shown by only a minority of the trees on plot XIV.

IV (*Holstein Doucin*).

Young Rootstock : " Showed plenty of fibre, but the coarse lateral roots were noticeably shallow in the soil, usually being not more than 4″ or 5″ deep."

Bramley's : Almost entirely horizontal, rather poorly anchored, roots moderate in number, many being small roots which continue for a considerable distance without decreasing in diameter, moderate amount of fibre near trunk, large dead roots on two trees.

Worcester : Horizontal, tendency to be one-sided, rather weakly anchored, roots large-medium, fair amount of fibre. The amount of fibre was greater on plot XIV.

V (*Doucin Amelioré*).

Young Rootstock : " Seem to show a somewhat curious mixture of rather bare deep rooting laterals, together with much fibre immediately around stem of stock."

Bramley's : Very similar in appearance to II, from which it may be distinguished by its less conspicuous lenticels and the presence of slightly more fibre along the main roots, galls on five trees.

Worcester : Mainly horizontal, roots mostly large to medium, several rather light in colour, fair amount of fibre, mostly around trunk, tendency for a few vertical roots below or near trunk, small gall on one tree on plot XIV. The tendency for the fibre to be mostly near the trunk was observed on plot XIV, but not on plot XIII.

VI (*Nonsuch Paradise*).

Young Rootstock : " Its mature system is somewhat similar to that of type I showing plenty of root fibre side by side with the coarse lateral roots."

Bramley's : Mainly horizontal, but some trees have roots showing a downward tendency, a few large and many small and medium roots dark in colour, a considerable amount of fibre well distributed over the whole system, galls on one tree. A rather similar system to that of No. III but considerably more vigorous, and having rather more small and medium sized roots.

Worcester : Mainly horizontal, roots mostly large and medium, large amount of fibre, tendency for several vertical or sloping roots near trunk. This tendency was not observed on plot XIII, where the systems were horizontal. While on plot XIII No. VI had the most fibre of all the stocks, on plot XIV it had about the same amount as No. I.

VII (*Unnamed*).

Young Rootstock : " In its later development it shows numerous medium coarse lateral roots without any large quantity of root fibre. In this respect it somewhat approaches the Doucin, except that the roots are not so coarse."

Bramley's : Horizontal, poor anchorage, inclined to be one-sided, roots rather few, moderate amount of fine root and fibre, galls on six trees, one medium sized scion root on one tree. A somewhat variable and uneven set. This was the most shallow rooted of all the rootstocks, the main roots running absolutely horizontal, just below ground level.

Worcester: Horizontal, tendency to be one-sided, only moderately well anchored, roots medium to medium small, amount of fibre varies from large to small, galls numerous.

VIII (*French Paradise*).

Young Rootstock: "The more mature roots, though they show a mixture of fibre and coarse lateral root, appear much less vigorous than Broadleaf or Nonsuch."

Bramley's: Small to very small system with extremely poor anchorage, horizontal, inclined to be one-sided, roots brittle and dark in colour, fair amount of fibre. Each of the three trees grubbed had two or three medium scion roots, but these had not yet supplanted the stock roots as the main roots of the tree.

Worcester: Not worked on VIII.

IX (*Jaune de Metz*).

Young Rootstock: "The lack of early vigour of VIII and IX seems reflected in the subsequent root-systems which have developed with a general lack of sturdiness."

Bramley's: Small to very small system, poorly anchored, horizontal, roots brittle and dark, moderate or slight amount of fibre, galls on one tree. In all cases except one, the trees had several large scion roots to which the original stock roots had become subsidiary. On two trees the stock appeared to be dying, whilst one tree had been blown out of the perpendicular some years earlier, and was entirely dependent on the scion roots for its support.

Worcester: The smallest root-system, poorly anchored, roots few, medium to large, mostly medium, brittle, a few small fleshy roots, amount of fibre variable but never abundant, lower roots which are smallest have downward tendency, small scion roots on two trees, scion stem smaller than stock stem.

X (*German Seedling from Späth, Berlin*).

Young Rootstock: Description from photograph. Horizontal and at angle of 45°, moderately vigorous with much fibre.

Bramley's: Mainly horizontal, roots numerous, large amount of fibre in characteristic tufts at intervals along the roots, small gall on one tree.

Worcester: Horizontal, roots medium-large, large amount of fibre.

XI (*Unnamed*).

Young Rootstock: No description.

Bramley's: Horizontal, except for a few small vertical roots below trunk, large roots leave trunk rather steeply but almost at once become horizontal, roots very numerous with much fibre (the most of any of the stocks), making a very dense and matted system, small galls present to a considerable extent on all trees, and roots inclined to have a scabby appearance.

Worcester: Mainly horizontal, a few medium and small roots going straight down, several large and medium-large roots, a few medium ones, a lot of small fleshy roots and fibre on most trees, galls present on all trees.

XII (*Unnamed*).

Young Rootstock : Very vigorous and wide range, very many strong coarse laterals, fair amount of fibre, also many medium sized laterals with much fibre, roots run parallel with surface, none directly downwards. Very firm anchorage.

Bramley's : Mainly horizontal, with several vertical roots, numerous (particularly small and medium), bare and fangy, a small amount of fibre near trunk.

Worcester : Mainly horizontal, numerous roots of varying sizes from large to small, a few to several large, medium and small roots growing downwards, very little fibre.

XIII (*German Seedling from Späth, Berlin*).

Young Rootstock : Description from photograph. Horizontal with very few vertical roots, vigorous, much fibre near stem.

Bramley's : Horizontal with a few vertical roots, roots somewhat few and large, moderate amount of fibre, gall on one tree.

Worcester : Horizontal, fewer roots than on XII, also fewer medium and small roots, little fibre.

XIV (*German Seedling from Späth, Berlin*).

Young Rootstock : Description from photograph. Horizontal with a few vertical roots near stem, vigorous, fair amount of fibre.

Bramley's : Horizontal with several vertical roots, roots numerous, moderate amount of fine root and fibre, gall on one tree. Somewhat like No. XII, but with much more fibre.

Worcester : Few to several medium-small roots, branching down from larger horizontal ones, roots numerous, similar to XII in number but curl about and cross one another, fibre varying from little to very much.

XV (*German Seedling from Späth, Berlin*).

Young Rootstock : Description from photograph. Roots mainly at an angle of 45°, vigorous, large amount fibre, mainly near stem.

Bramley's : Horizontal, with fair to large amount of fibre, very similar to No. XIV.

Worcester : Rather like XII, but slightly fewer roots, and fewer going down, a little fibre.

XVI (*German Seedling from Späth, Berlin*).

Young Rootstock : No description.

Bramley's : Horizontal with some vertical roots, roots numerous, large, with a little fibre along the main ones, but none arising from stock stem, considerable root fusion in some trees.

Worcester : Mainly horizontal, with a few roots going downward, numerous roots, from large to small in size, mostly large, very little fibre, some forking and crossing of roots.

E (*Vegetatively-raised Crab Stock*).

Young Rootstock : Description from photograph. A large mass of fibrous, almost vertical roots, moderately vigorous.

Bramley's : Horizontal with some vertical roots, inclined to be one-sided, roots moderate in number, with large amount of fine root and fibre, mainly arising from stock stem, main roots almost bare.

Worcester: One tree only. Three large roots branching off to few medium to large ones, direction downwards for about six inches, then nearly horizontal, much fibre.

F (*Vegetatively-raised Crab Stock*).

Young Rootstock: Description from photograph. Mainly horizontal, rather weak, roots rather few, fair amount of fibre near stem, burr knots on stem.

Bramley's: Horizontal, with some vertical roots, roots numerous, with fair amount of fibre distributed along main roots.

Worcester: Roots vary from horizontal to vertical, numerous, mainly large and medium, hardly any fibre.

*OF*5 (*Long Ashton Layered Free Stock*).

Young Rootstock: No description.

Bramley's: Mainly horizontal with a few small vertical roots, roots very numerous, somewhat bare and fangy, very little fibre or fine root.

Worcester: Numerous large to small roots, considerable forking, bending and crossing of the roots, a few turning or branching straight down from horizontal larger roots, very little fibre.

Scion Rooting.

This occurred with Bramley's on stocks II, VII, VIII and IX. On the latter two stocks it had assumed serious proportions, whilst in the case of stock IX all the trees except one were almost entirely established on their own roots. Scion rooting did not occur on Worcester except to a slight extent on two trees on IX.

Comparison of the Root-Systems of Worked Trees with those of Unworked Rootstocks.

III. In Bramley's the downward tendency of the roots shown by the young unworked stocks has not persisted, the roots of the worked trees being almost entirely horizontal, though on some trees the roots leave the stock at an acute angle, but rapidly flatten out, giving the appearance of a flat cone. With Worcester the downward tendency was shown by only one of ten unmanured, and one of five manured trees, though on two of the remainder, some medium-small roots left the trunk at 45° or almost vertically. The roots cannot be described as very fibrous, or less coarse than those on I and VI.

IV. Both Bramley's and Worcester are similar, but with the latter the amount of fibre was only fair to small.

V. The trees worked with Bramley's had root-systems quite as strongly developed as those on I and II, and the abundance of fibre around the stock had not persisted, the amount being only small. When worked with Worcester, the root-system is similar, but the amount of fibre is only fair on most trees. Though on a number of trees there were several vertical roots below or near the trunk, only a few root-systems showed a downward tendency; they were mainly horizontal.

VII. With both Bramley's and Worcester the root-system no longer resembles that of No. II, but is entirely horizontal with more fibre.

X. With Bramley's it is similar, but with Worcester it differs in being entirely horizontal.

XII. Worked trees of both varieties differ from the unworked stocks in having a fair number of vertical roots and only a small amount of fibre.

XIII. Both varieties differ in having less fibre.

XV. With Bramley's it is similar, but with Worcester it has less fibre.

E. Both varieties differ in having more horizontal root-systems.

F. When worked with Bramley's and Worcester it differs from the young stock in being strong, and with Worcester has hardly any fibre.

The roots of trees worked with Bramley's and Worcester did not differ from the young stocks with Nos. I, II, VI, IX and XIV.

A Comparison of the Root-Systems of Bramley's and Worcester on the same Rootstock.

I. Worcester has a tendency to be one-sided, and also has more fibre.

II. Worcester is rather more horizontal.

IV. Rather liable to be one-sided with Worcester, but only one tree of Bramley's had this tendency.

X. With Bramley's the fibre was in characteristic tufts along the main roots, but only one tree of Worcester showed this distribution. Worcester differed from Bramley's in being entirely horizontal.

XV. Worcester had rather less fibre than Bramley's.

F. Bramley's appears to have more fibre, but there are too few trees for a proper comparison.

The roots of Bramley's and Worcester did not differ materially on the following stocks :—III, V, VI, VII, VIII, IX, XI, XII, XIII, XIV, XVI, E and OF5.

Number and Size of Roots.

Measurements were made on all trees of Bramley's on plot XII and on Worcester on certain stocks on plot XIII.

All roots arising from the main stem, and more than 7 mm. in diameter, were measured at 25 cm. from the trunk.

The differences between the stocks as brought out by the root grading are shown in the following diagrams and table.

Bramley's Seedling.

Number and Size of Roots.

Stock.	No. of Trees.	Average No. of Roots.	Average Size of Roots.	Stock.	No. of Trees.	Average No. of Roots.	Average Size of Roots.
			mm.				mm.
I	8	16·80	40·10	XI	4	22·50	37·64
II	8	11·60	44·60	XII	8	23·60	35·20
III	8	12·12	41·78	XIII	8	11·75	53·05
IV	8	14·87	35·70	XIV	3	23·67	35·32
V	8	12·37	44·38	XV	8	23·12	35·28
VI	8	18·37	34·51	XVI	8	16·50	50·20
VII	8	14·70	33·40	Crab E	3	14·67	43·33
VIII	3	11·67*	24·96*	Crab F	4	22·50	37·31
IX	3	9·00*	25·72*	OF5	4	27·50	38·21
X	8	17·87	34·53				

* Excluding scion roots.

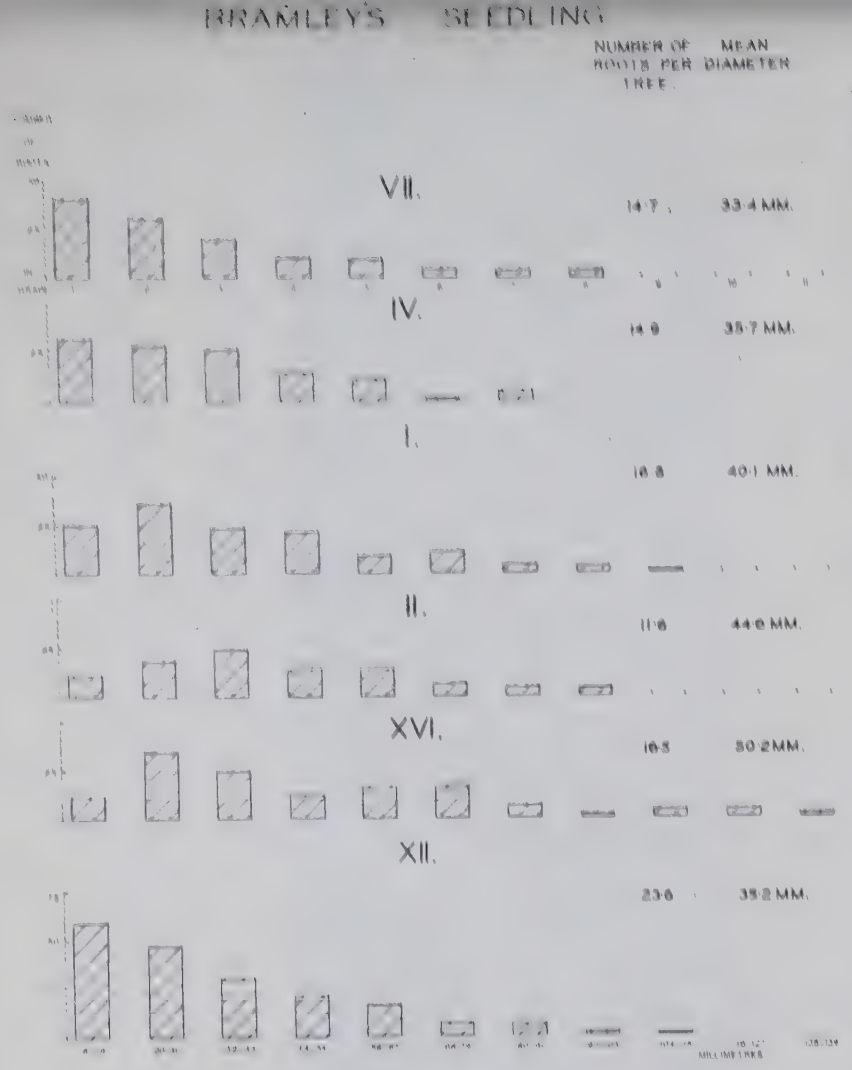

DIAGRAM I.

Roots graded according to size. Total of 8 trees on each stock.

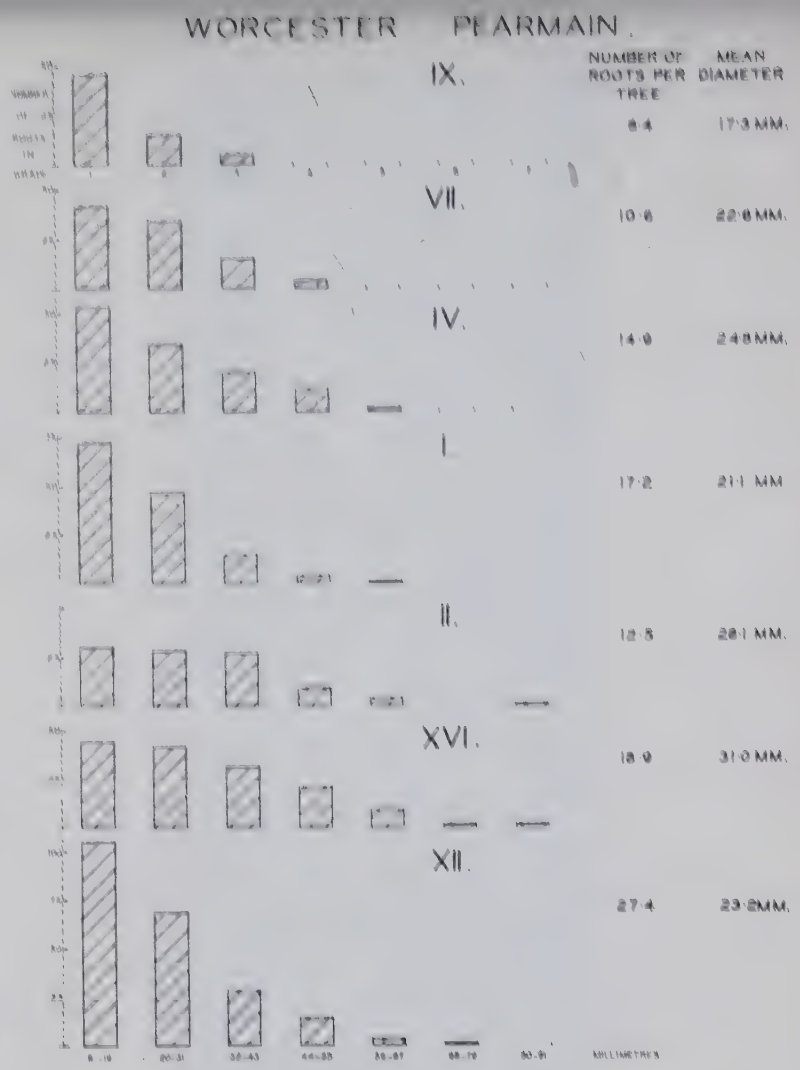

DIAGRAM II.

Roots graded according to size. Total of 8 trees on each stock.

Discussion.

Apart from the obvious difference between such stocks as IX and XVI the following points are of interest.

Two stocks of similar vigour may have very different types of root-system, as for instance Nos. XII and XVI. Both are very vigorous stocks, yet XII has a large number of roots mainly in the smaller grades, while XVI has only a moderate number which are, however, much larger. A similar difference is shown by stocks XIII and XIV. In comparing stocks I and II it will be seen that the latter has fewer and rather larger roots, the difference in size being more marked with Worcester.

There is a marked similarity between IV and VII, and between II and V.

The Long Ashton OF5 had the greatest number of roots whilst stock XIII had the largest.

Conclusions.

A comparison of the results obtained by this relatively rough method with those of a much more detailed examination (2,6) shows that the former enables one to obtain a correct general impression of the type of root-system. Owing, however, to the limited extent of the excavated area, it does not give the position of the small feeding roots and fibre, except where there is a mass of these near the stem.

While in the main the root-systems of the worked trees bear a general resemblance to those of the young unworked stocks, there are some exceptions. Most of these, however, are shown by both varieties, so it would appear that they are the result of difference in age rather than the effect of the scion on the stock. Such as are not common to both varieties are largely a matter of amount of fibre, which was difficult to estimate by this method.

If the rootstocks are classified according to the early vigour of the scion worked on them there is, with certain notable exceptions, a gradual increase in the number of roots in passing from the most dwarfing to the most vigorous, but in view of these exceptions it is unwise to draw any definite conclusions. Apart from this there appears to be no correlation between type of root-system and tree performance.

Acknowledgments.

The work on the Worcesters on plot XIII was done by Mr. E. G. Ing, who has since taken up an appointment in Jersey. The present authors are much indebted to him for permission to include the results of his work in this paper.

Our thanks are also due to Mr. J. Amos for taking the photographs and to Mr. T. N. Hoblyn for preparing the diagrams illustrating the results of the root grading.

Summary.

The removal of mature trees of Bramley's and Worcester on known rootstocks provided an opportunity for comparison of the root-systems of the two varieties and of both with those of young unworked stocks. Comparison with the results of a much more detailed examination made on a few trees at the same time showed that the relatively rough method was sufficient to give a general impression of the type of root system. It did not, of course, show the position of the small feeding roots and fibre except where there was a mass near the stem.

In the main, the root-systems of the worked trees bear a general resemblance to those of the young unworked stocks. There are some exceptions, but as most of these

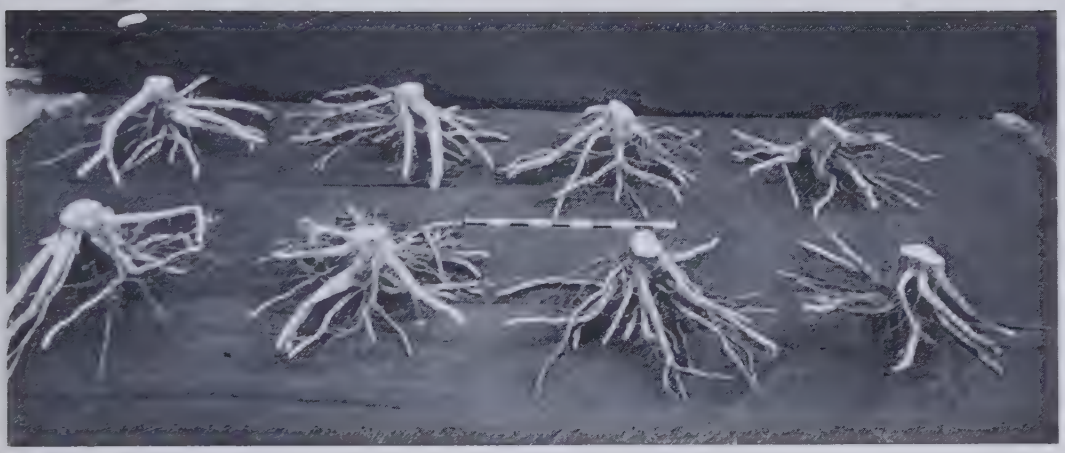

FIG. 1.

Thirteen-year-old root-system of No. I, Worcester, plot XIII.

FIG. 2

Thirteen-year-old root-system of No. II, Worcester, plot XIII.

Note uniformity in each stock.

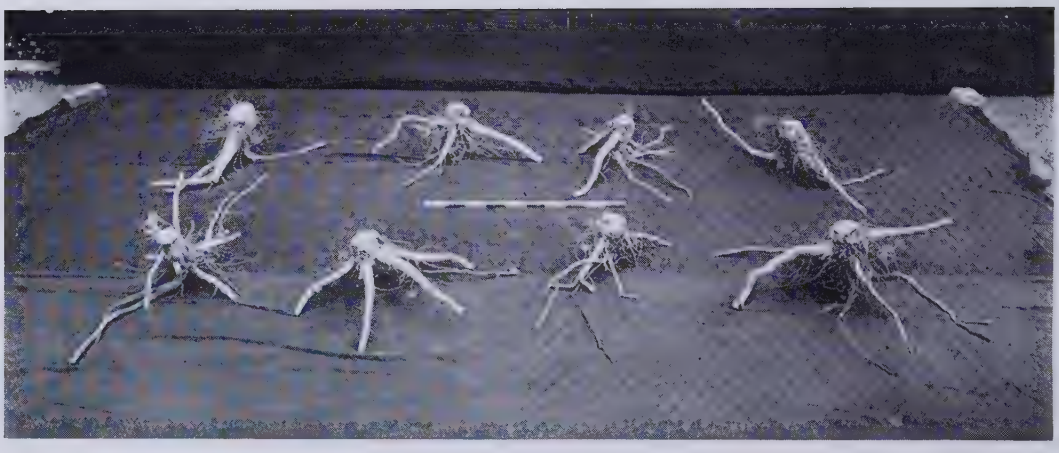

FIG. 3.
Thirteen-year-old root-system of No. IX, Worcester, plot XIII.

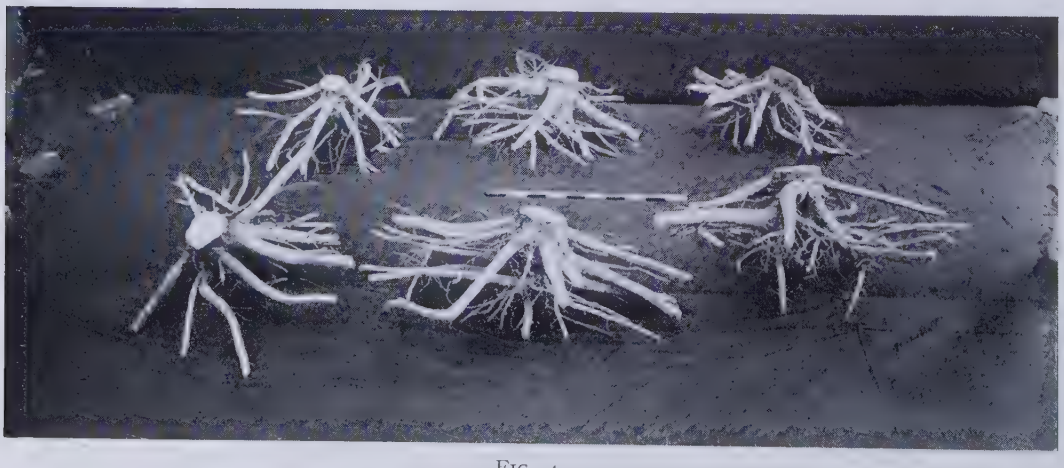

FIG. 4.
Thirteen-year-old root-system of No. XII, Worcester, plot XIII.

Note uniformity in each stock.

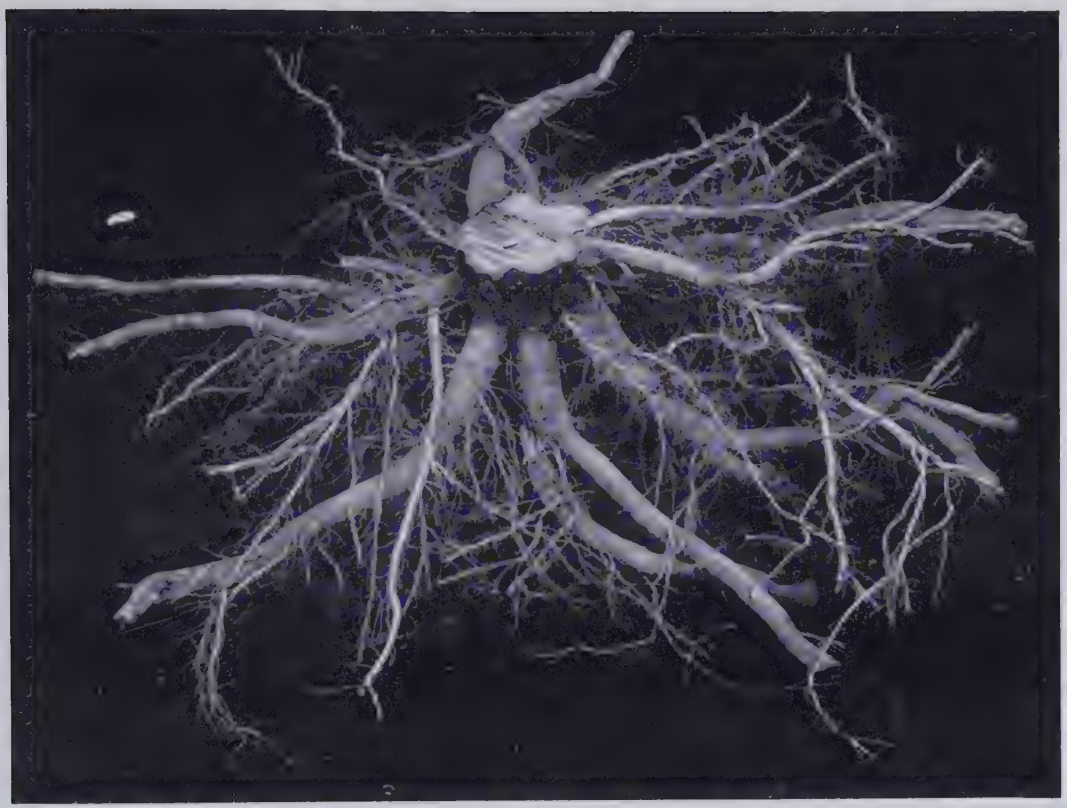

FIG. 5
Bramley on I. Note presence of fibre.

FIG. 6.
Bramley on II. Note few roots and absence of fibre.

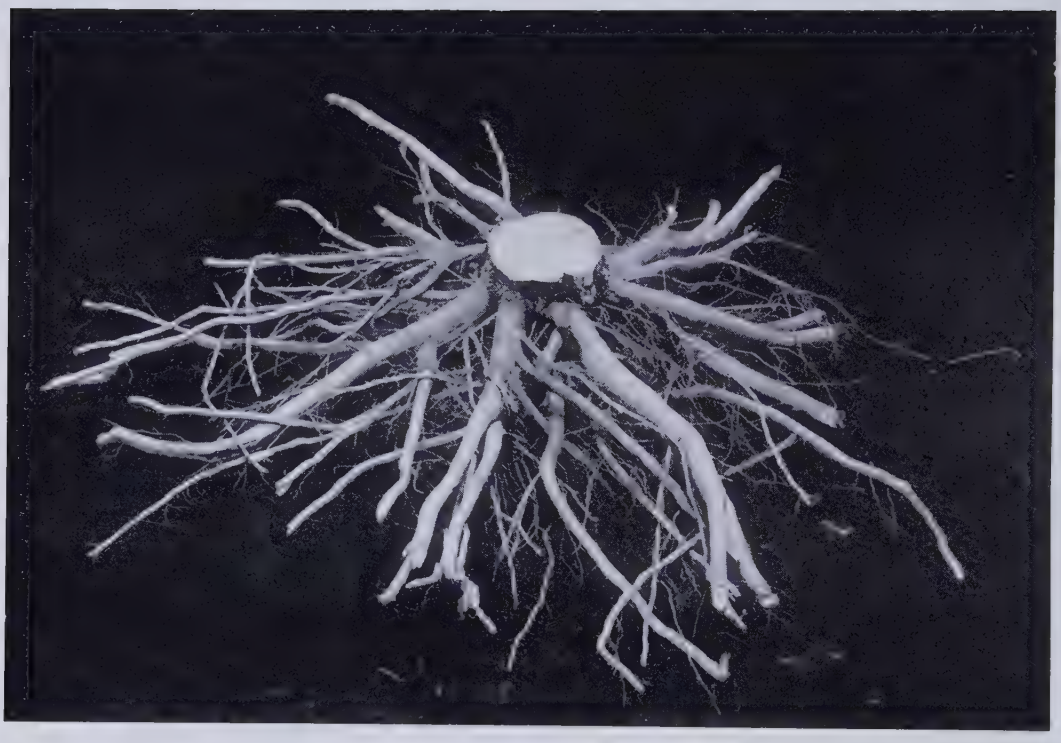

FIG. 7.
Bramley on XII.

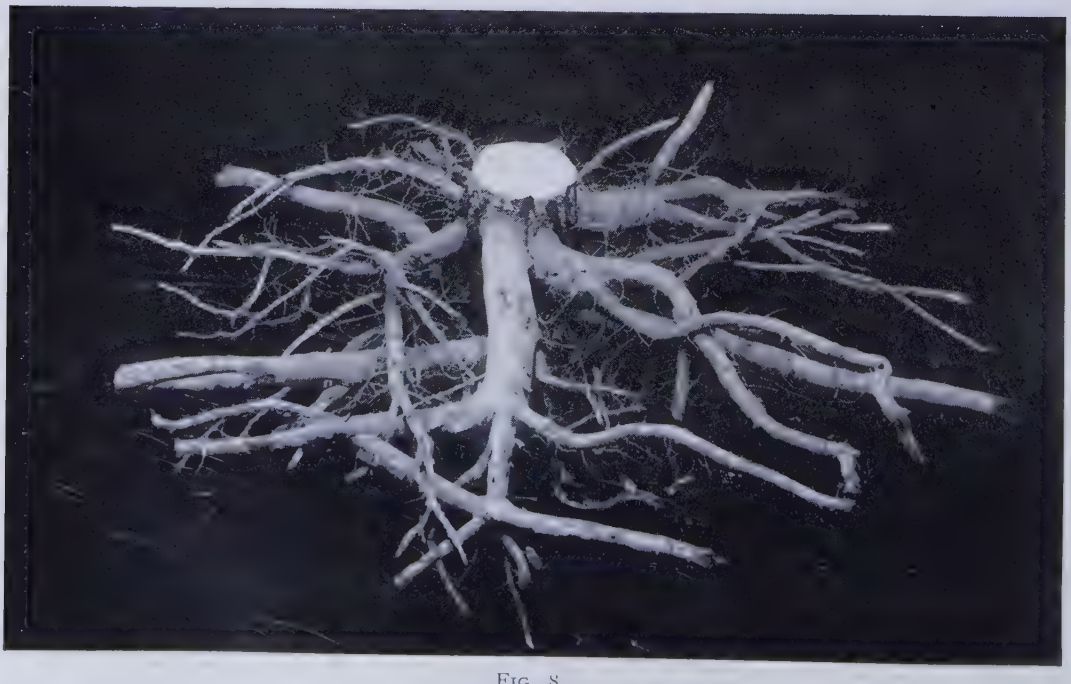

FIG. 8.
Bramley on XVI.
Note fewer but larger roots than on XII. Both are very vigorous stocks.

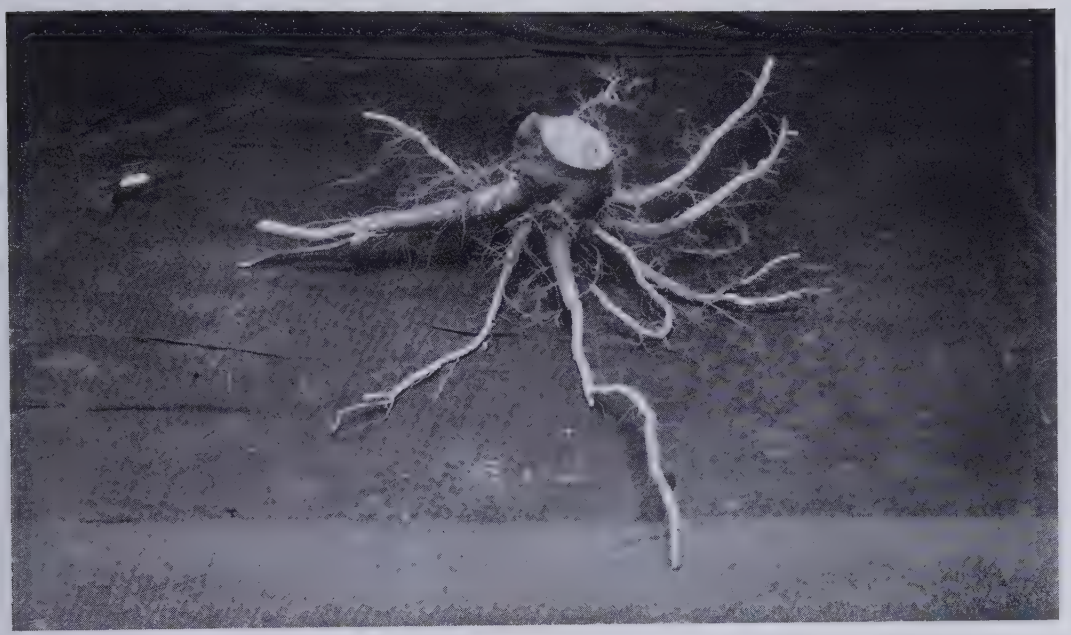

FIG. 9.
Bramley on IX.
Scion roots have been removed.

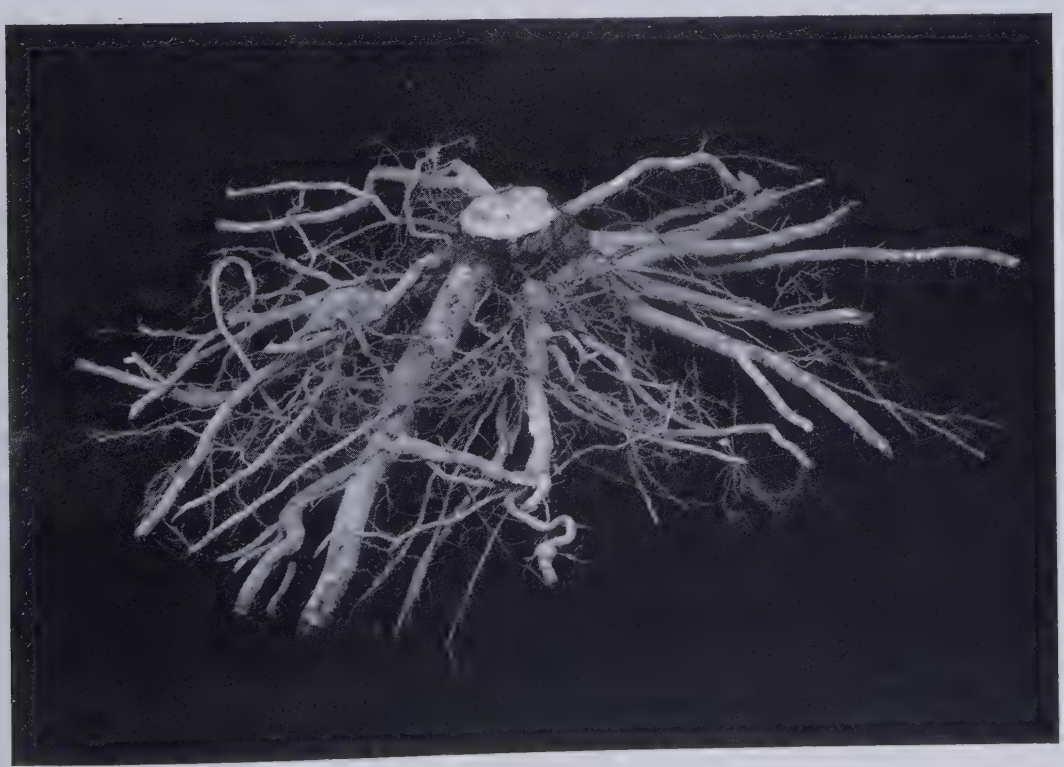

FIG. 10.
Bramley on OF5.
This is a very vigorous stock.

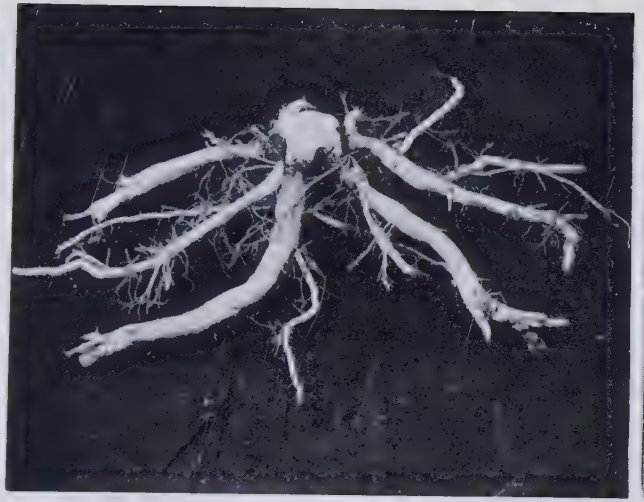

FIG. 11. Bramley on V. Bramley on XI.

Note similarity of V to II (Fig. 6).

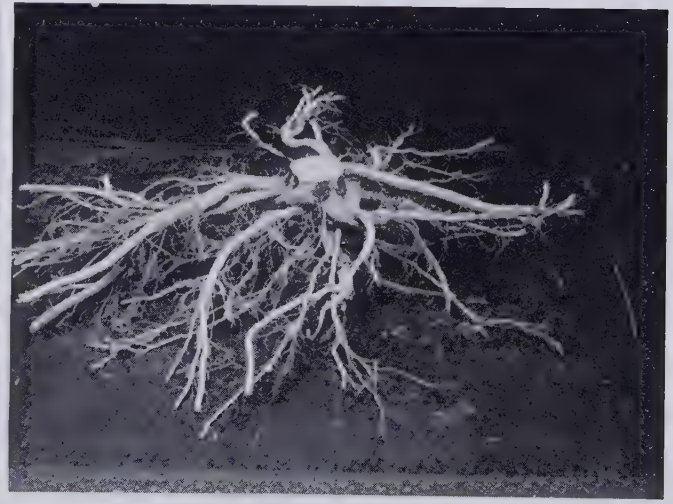

FIG. 12. Bramley on IV. Bramley on VII.

apply to both varieties they are probably the result of difference in age rather than the effect of scion on stock.

There appears to be no consistent correlation between type of root-system and tree performance.

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PERIODS OF BLOSSOMING OF SOME TREE AND SOFT FRUIT VARIETIES AT EAST MALLING

By A. B. BEAKBANE, H. C. CHAPELOW and N. H. GRUBB

The time of blossoming of variety collections of various fruits has been recorded annually in the course of routine records on these plots. In some cases the collections have been grubbed a few years after the plants have come into blossom and records are only available over a short period. The fact that the order of flowering and duration of the blossom period might have been slightly different if records had been taken over a longer period must be borne in mind in studying some of the diagrams given below. As knowledge of the comparative time of blossoming is very valuable both as an aid to the identification of varieties and in connection with cross-pollination, the figures are included even where only available for a few years.

With regard to tree fruits, individual tree records were taken in most cases, but with soft fruits the average of a number of plants was judged at the time the record was made. The records taken were :

(1) The opening of the first flower.

(2) The time when approximately 50 per cent. of the flowers were open and 50 per cent. not yet open (this period is referred to as " full bloom ", and marked by a cross in the diagrams).

(3) The time when approximately 90 per cent. of the flowers had fallen. (In the case of cherries until all but a few scattered blossoms had dropped.)

The limitations of this method of recording have already been pointed out by Hatton and Grubb (1). A much more accurate method has been worked out by Irwin (2), which is particularly suitable for detailed study of the different effects of various treatments, but is not so suitable for recording the whole period of blossoming on a large number of trees over a period of years, and this is necessary in order to provide reliable information with regard to cross-pollination. An ideal arrangement would be to use both methods, but this would involve a great deal of labour.

The names given to the varieties in the diagrams below are those under which they were received ; where the variety is thought to be incorrectly named, a note is made in the column headed " Remarks ". Some unnamed varieties received from growers are called by the name of the sender and put in inverted commas, as for example " Carter's Pearmain ". It is probable that some of these varieties have other names.

Apples.

(a) *Bush.*

The apples listed in Diagram 1 include varieties known to keep well in ordinary store, high quality dessert sorts, some of the newer kinds, most of the better known American and a few Continental varieties. Altogether about eighty varieties were planted as maidens in December, 1921. They were grown as bush trees and given the usual hard pruning up to four years of age. From that time one-half of each unit has

been left with leaders untipped. In all cases the observations have been taken on the non-leader-tipped trees, only one tree, the first in each unit, being recorded. The varieties in this collection are all on Improved Doucin (Malling No. V) with the exception of a few at the end of the diagram, which are on IX and II, as indicated.

With regard to early and late blossoming seasons, it may be worth noting that the seasons of :

1927 and 1928 were early,
1930 and 1931 about average,
1929 and 1932 late.

Two years later another plot of some forty-two varieties was laid down. The treatment of the trees and observations have been the same as those for the first collection. In Diagram 2 are listed some eighteen varieties, all on Improved Doucin (Malling No. V) with the exception of two Gravenstein and White Transparent, which are on Doucin (No. II). The remaining fifteen varieties are given in Diagram 3. These are on Jaune de Metz (No. IX). The observations on the varieties in these two tables were conducted over a four-year period, 1930 to 1933 inclusive. Again the varying seasons should be noted : 1930 and 1931 were average, 1932 late as previously noted, while 1933 was an early season.

(b) *Cordons.*

A number of dessert apples, which are of particular interest either pomologically or for breeding work have been worked on rootstock No. IX and trained as single oblique cordons. This collection is intended to serve only as a " Library " and not to be considered as a cordon trial.

The pruning has been varied according to varietal habit, but all have been long-spurred in winter, and the laterals summer pruned once to six leaves towards the end of July or beginning of August. Varieties, such as Cornish Gillyflower, which make few natural spurs, have been pruned very lightly and long weak shoots up to 6 or 8 inches have been left unpruned.

The average time of blossoming of ten trees was judged at the time that the record was taken, only spur blossoms being taken into account, as axillary blossoms of apples generally open about seven to ten days later than spur blossoms, and in cordon trees it is comparatively easy to observe these different kinds of blossoms separately. The average time of blossoming for four years from 1931 to 1934 is shown in Diagram 4.

PEARS.

The time of blossoming of some pear varieties on quince and free pear stock was recorded from 1929 to 1931 inclusive. A group of Dutch pears, which are not much grown in this country, are included in Diagram 5, in addition to some better known varieties. Records are only available for two years for the eight varieties at the end of the diagram and therefore the average of the first two years of the Conference records are included again, so that a comparison can be made with the rest of the diagram.

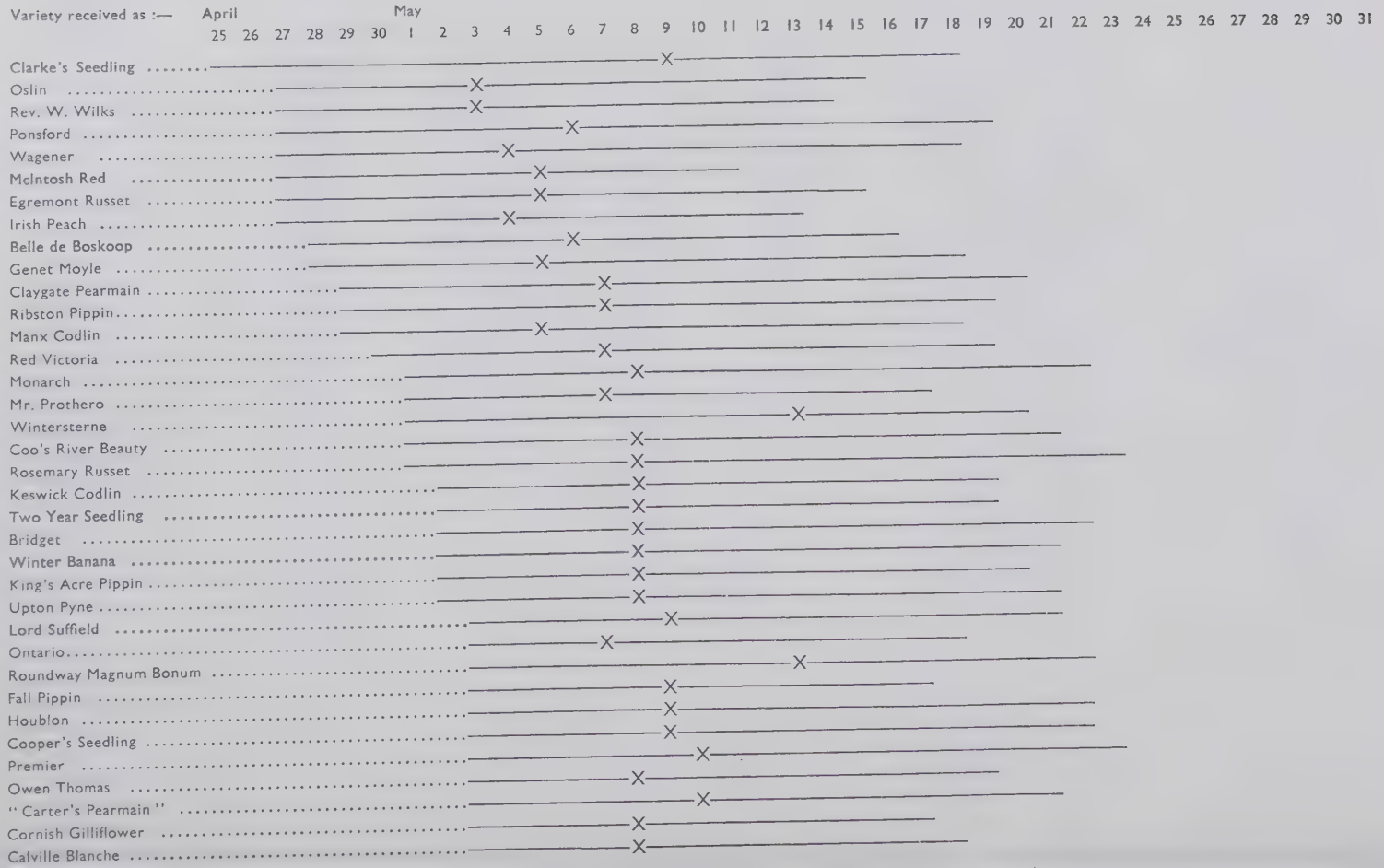
PLUMS.

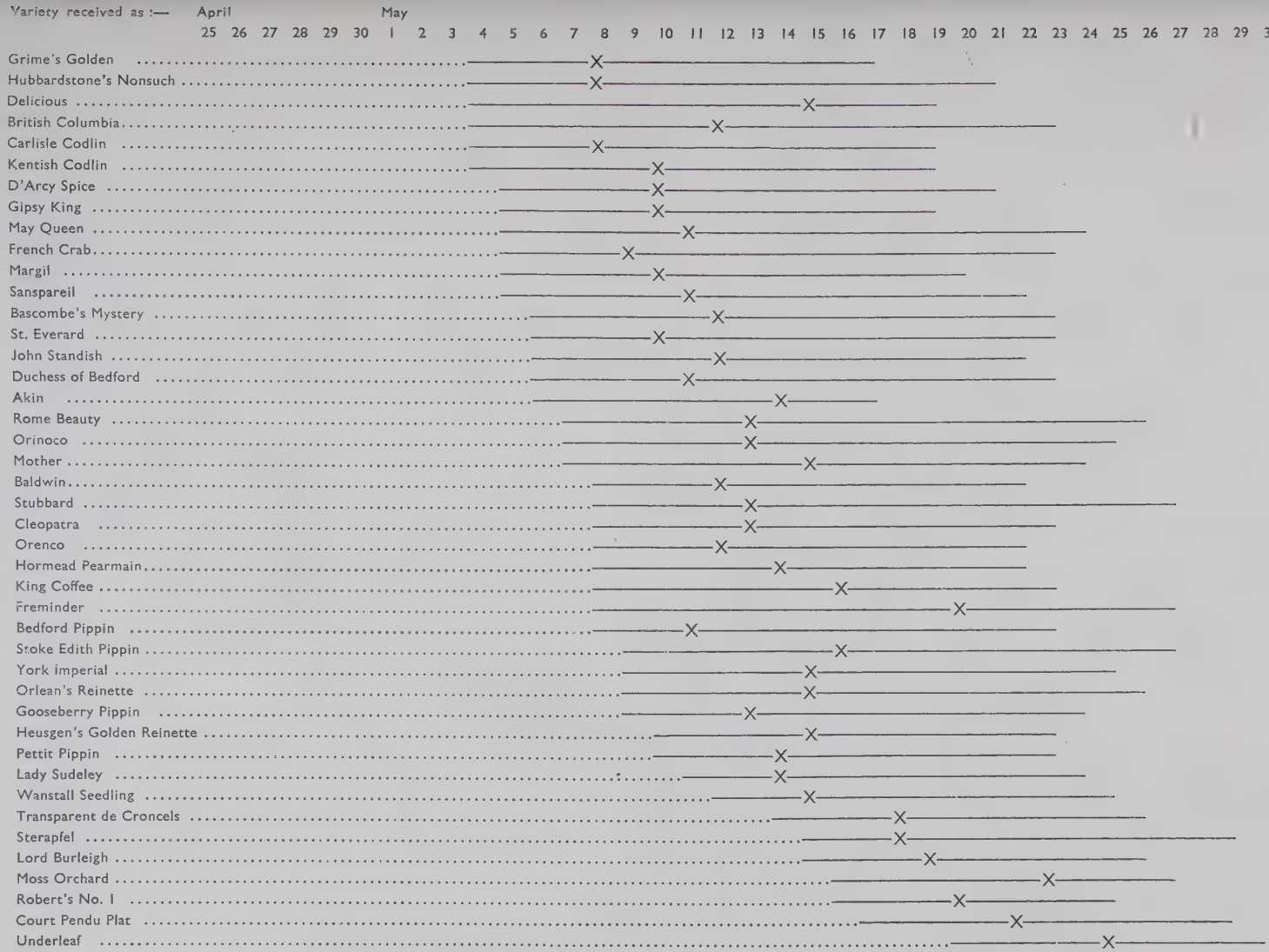
The average time of blossoming for three years of nine varieties of plums worked on Common Mussel is shown in Diagram 6. As the trees are not all the same age, the date of planting is given in the diagram.

BLOSSOMING PERIOD—APPLE VARIETIES.

BUSH TREES PLANTED DECEMBER, 1921, ON ROOTSTOCK NO. V, IMPROVED DOUCIN.

Average for Six Years, 1927 to 1932 inclusive.



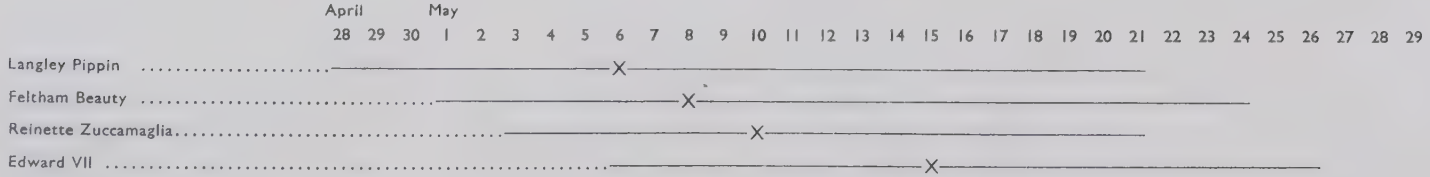

Variety received as :—
April
May
25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Grime's Golden
Hubbardstone's Nonsuch
Delicious
British Columbia
Carlisle Codlin
Kentish Codlin
D'Arcy Spice
Gipsy King
May Queen
French Crab
Margil
Sanspareil
Bascombe's Mystery
St. Everard
John Standish
Duchess of Bedford
Akin
Rome Beauty
Orinoco
Mother
Baldwin
Stubbard
Cleopatra
Orenco
Hormead Pearmain
King Coffee
Freminder
Bedford Pippin
Stoke Edith Pippin
York Imperial
Orlean's Reinette
Gooseberry Pippin
Heusgen's Golden Reinette
Pettit Pippin
Lady Sudeley
Wanstall Seedling
Transparent de Croncels
Sterapfel
Lord Burleigh
Moss Orchard
Robert's No. 1
Court Pendu Plat
Underleaf

BLOSSOMING PERIOD—APPLE VARIETIES.

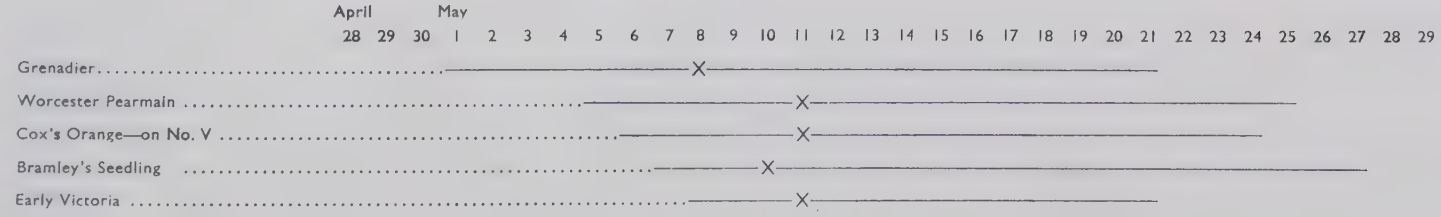
Bush Trees Planted December, 1921, on Rootstock No. IX and No. II.

Average for Six Years, 1927 to 1932 inclusive.

On No. IX. Jaune de Metz.


April
May
28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
Langley Pippin
Feltham Beauty
Reinette Zuccamaglia
Edward VII

On No. II. Doucin.


April
May
28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
Grenadier
Worcester Pearmain
Cox's Orange—on No. V
Bramley's Seedling
Early Victoria

BLOSSOMING PERIOD—APPLE VARIETIES.

BUSH TREES PLANTED WINTER, 1923-4, ON ROOTSTOCK NO. V, IMPROVED DOUCIN.

Average for Four Years, 1930-3 inclusive.

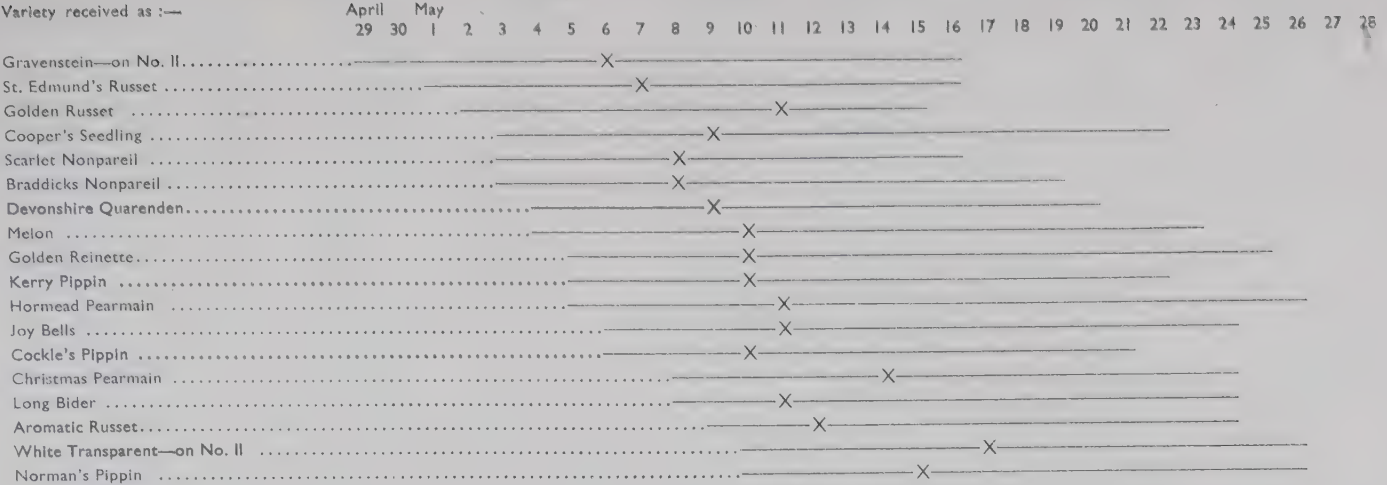
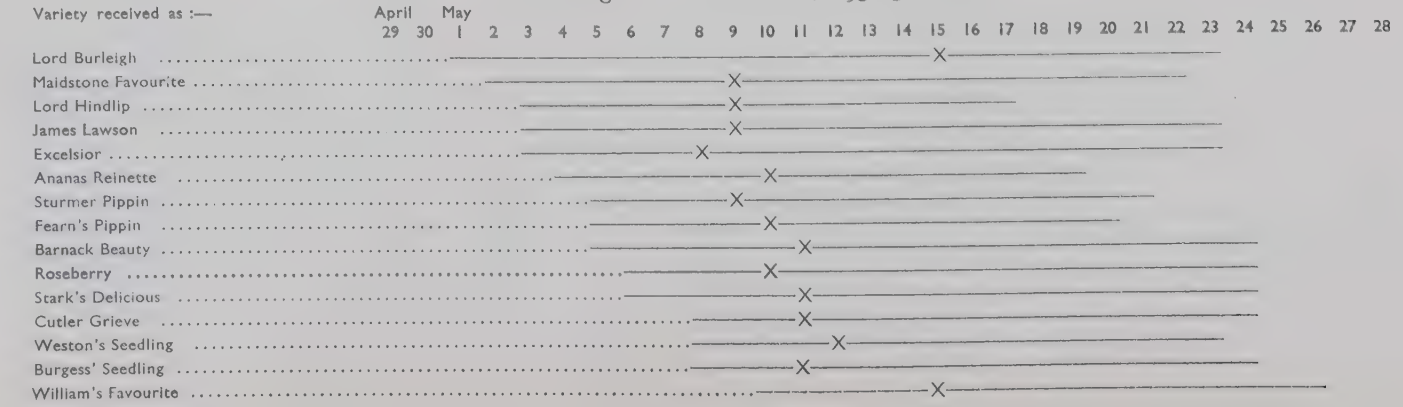


DIAGRAM 3.

BLOSSOMING PERIOD—APPLE VARIETIES.

BUSH TREES PLANTED WINTER, 1923-4, ON ROOTSTOCK NO. IX, JAUNE DE METZ.

Average for Four Years, 1930-3 inclusive.



Three trees of each of eight varieties of damsons were planted in 1925 and the time of blossoming of individual trees was recorded for three years from 1929 to 1931. The average period of blossoming for these years is shown in Diagram 7.

CHERRIES.

The cherry variety collection at East Malling was begun in February, 1921, with one tree of each of twenty-seven varieties, presented by Mr. E. A. Bunyard. Eighteen varieties have now provided blossom records for six years ; of these, fourteen are sweet cherries, two are Dukes and two are acid cherries. The average dates are set forth in Diagram 8.

Scions from these twenty-seven trees, and from varieties subsequently added to the collection, were worked on layered Mazzard stocks, and the resulting trees were planted at intervals, beginning in March, 1926. Four years' blossom records have been obtained from nearly all the oldest of these trees, together with a few from trees received from various sources in February, 1926. The average dates are presented in Diagram 9.

Few trees planted later than March, 1926, have as yet given more than three years' blossom records. Since the blossom periods of trees of different ages are not strictly comparable, and since three years is too short a period for thorough reliability, these records are not presented in a diagram, but are merely listed in the text below.

In Diagram 9, column 2 gives the index numbers of the layered Mazzard stocks used in working the trees raised at East Malling. Records so far available from cherry stock trials, with either sweet or acid cherry scions, do not as yet suggest that the Mazzard stocks here mentioned have any consistent influence on the period of blossoming of the scion. Such an influence, however, may yet appear.

Column 3 gives the source from which trees or scions were actually received at East Malling. A majority came from growers, a number from nurserymen, and a few from County Officers. Whilst several varieties, notably those from Herefordshire and Devonshire, are believed to be only locally known, at least under the names given, many of those received from Kent are much more widely grown.

The following points are worth noting :

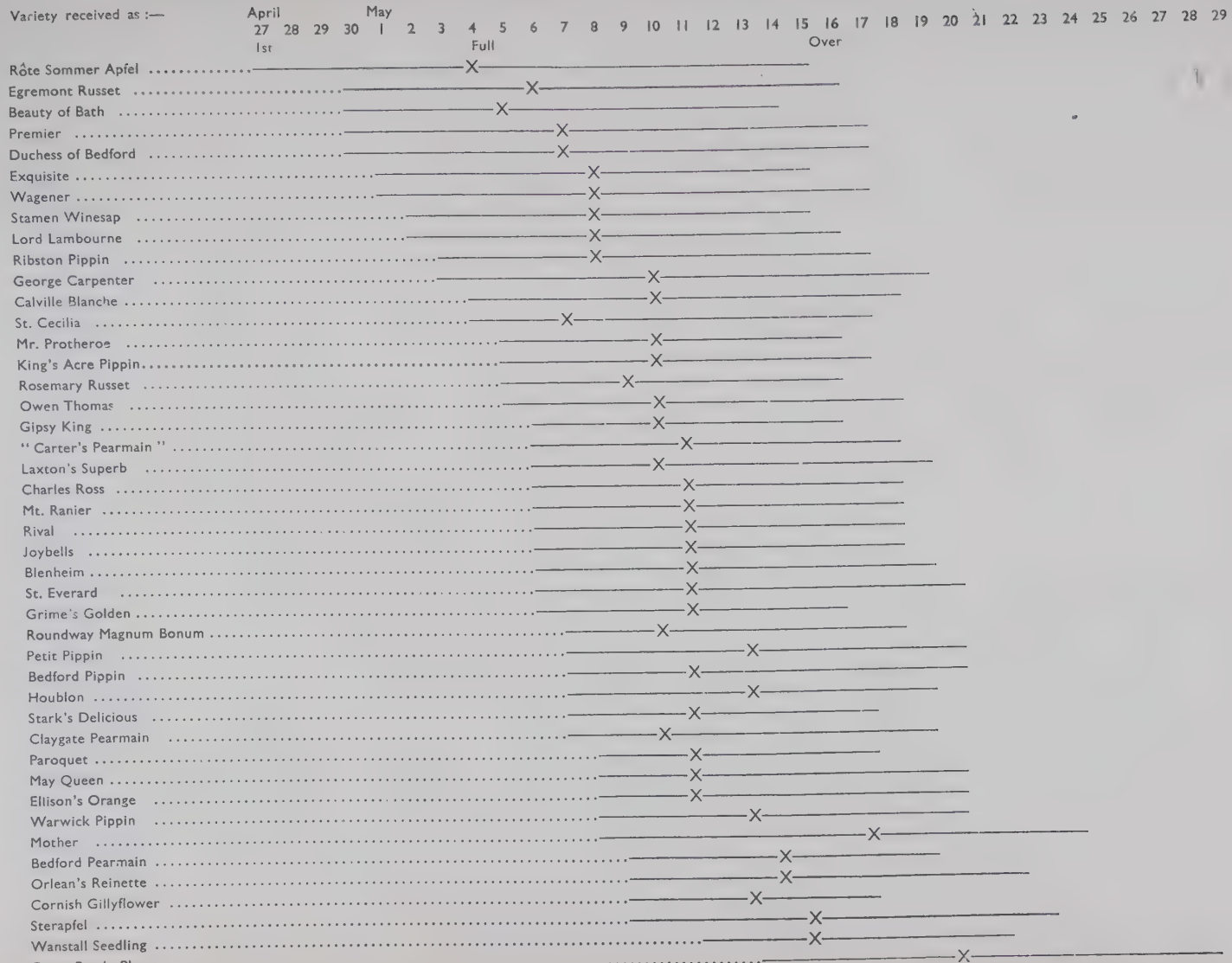
(i) As with other tree fruits, early and late blossoming varieties do not overlap enough in season for satisfactory cross pollination. In planning a cherry orchard, this fact, as well as the cross incompatibility described by Crane and Lawrence (3), must be allowed for.

(ii) Neither diagram includes such well-known late blossoming varieties of sweet cherry as Napoleon, Florence, Noble, and Bradbourne Black. The trees of Napoleon in the variety collection are still too young to have given usable records ; of the other three varieties the trees have been severely damaged, and in some cases killed, by Bacterial Canker, and the records are therefore incomplete.

(iii) Varieties differ in the length of their blossoming period, and also in the relative position of their time of " full " bloom. Turkey Heart occurs once in Diagram 8 and twice in 9 ; in each case it has a much shorter blossoming period than the neighbouring varieties. Frogmore has a notably late time of " full " bloom ; this cannot be the result of accident, since the two trees, planted at the same time and apparently identical, and raised from scions from different sources, have been consistent in this respect over four years.

BLOSSOMING PERIOD—APPLE VARIETIES—CORDONS.

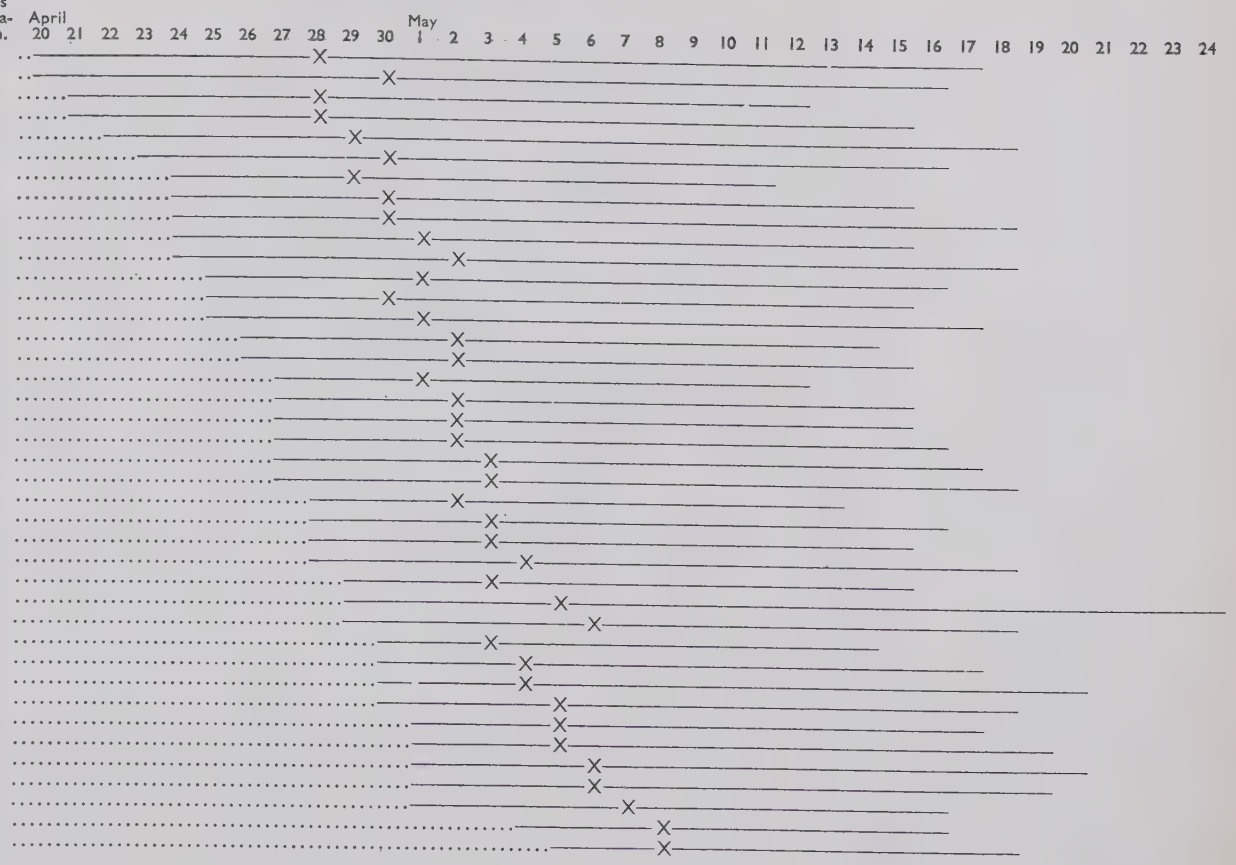
On No. IX, 1931-4 inclusive.



BLOSSOMING PERIODS—PEAR VARIETIES.

Average for 1929-31 inclusive.

Variety received as :—	Stock.	No. of Trees.	Days Duration.
Beurré d'Esperen	Quince A	4	28
Vicar of Winkfield	Quince A	2	27
Comtesse de Paris	Quince & Pear	4	22
Louise Bonne	Quince A	4	25
Herzogin Elsa	Quince	4	27
Beurré Easter	Quince A	4	24
Précose de Trevoux	Quince & Pear	4	18
Beurré Alexander Lucas	Quince B	16	22
Bellisime d'Hiver	Quince A	2	25
Roosevelt	Quince A	4	22
Beurré Superfin	Quince A	4	25
Beurré d'Amanlis	Quince A	4	23
Durondeau	Quince A & B	16	21
Admiral Gervais	Quince A	4	23
Emile d'Heyst	Quince A & B	24	19
Vygenpeer	Quince	4	20
Beurré de Merode	Quince & Pear	4	16
Fondante de Thirriot	Quince B	16	19
Marguerite Marrilat	Seedling Pear	2	19
Beurre de Jonghe	Quince A	4	20
William's Bon Chretien	Quince A	2	21
Seigneur d'Esperen	Quince	4	22
Le Brun	Quince A	4	16
Conference	Quince A	16	19
Fondante d'Automne	Quince A	4	18
Belle Julie	Quince A	4	21
Sucker Peer	Pear	4	17
Maagdepeer	Pear	4	26
Doyenne George Bouchier	Quince A	10	20
Jargonelle	Seedling Pear	2	15
Orange Bergamot	Seedling Pear	6	18
Gieser Wilderman	Pear	4	21
Fertility	Quince A	16	19
Pitmaston	Quince A	16	17
Roode Suckery	Pear	4	19
Hessle	Quince A	16	20
Nouveau Poiteau	Quince & Pear	4	19
Zwyder Wynpeer	Quince & Pear	4	16
Pitmaston	Pear A	8	13
Clapps Favorite	Pear A & B	6	14



1929-30 inclusive.

Variety received as :—	Stock.	No. of Trees.	Days Duration.
Kleipeer	Pear	4	24
Duchesse de Bordeaux	Quince A	4	19
Josephine de Malines	Quince A	4	20
Gilogil	Quince A	4	24
Juttepeer	Quince & Pear	4	16
Conference	Quince A	16	19
Ooms Kinderenpeer	Pear	4	24

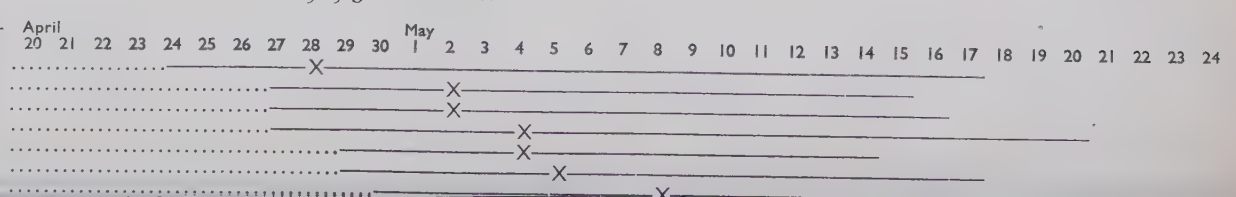


DIAGRAM 6.

BLOSSOMING PERIOD—PLUM VARIETIES ON COMMON MUSSEL.

Average for three years 1931, 1932, 1934.

Variety received as :—	Planted in	No. of Trees.	Days Duration.
Utility	1926	3	19
Warwickshire Drooper	1924	9	21
Bastard Victoria	1924	4	19
Pershore Egg	1924	7	20
Czar	1926	12	19
Cambridge Gage	1924	5	18
Victoria	1928	—	15
Blaisden Red	1924	5	18

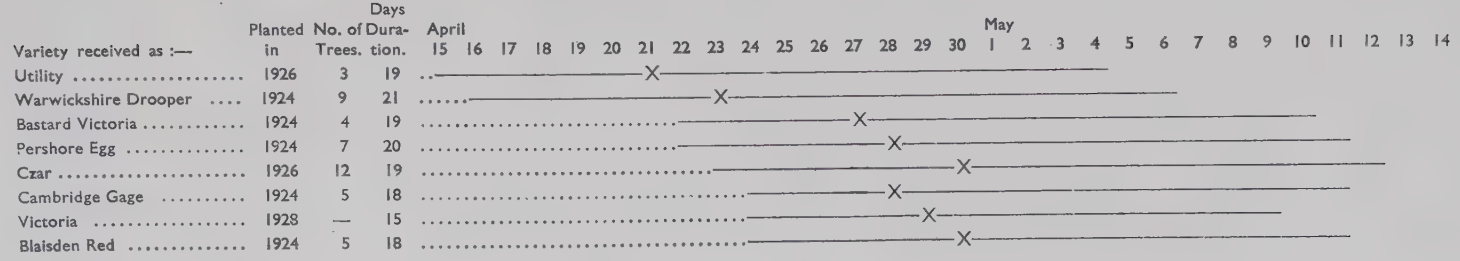
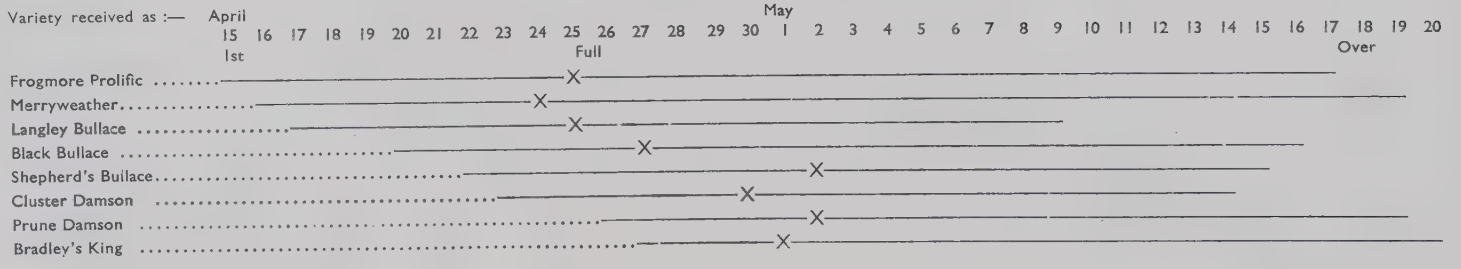


DIAGRAM 7.

BLOSSOMING PERIOD—DAMSON VARIETIES.

1929-31 inclusive.



(iv) Whilst most of the early blossoming varieties are early ripening, and vice versa, there are exceptions. For instance, Windsor, early, and Turkey Heart, early midseason, in blossoming, are both rather late ripening; whilst Frogmore and Governor Wood, rather late blossoming, are somewhat early ripening. Varieties of cherries evidently differ, as do varieties of other fruits, in the time required from blossoming to ripening.

(v) Where two or more varieties have the same name, and no alternative, they are distinguished as " A ", " B ", etc. The two varieties known as " Baumann's May " are certainly distinct, and both appear to be distinct from Early Rivers, which they somewhat resemble.

(vi) Varieties for which less than four years' records are available include the following, in order of their first blossom opening :

	Variety received as :	*Source.*	*Remarks.*
Sweet cherries :	Lulsley Early Black	Hereford.	
	Rockport Bigarreau	California.	
	Smoky Dunn	Hereford.	
	Early May	Worcestershire.	*Sweet* cherry.
	California Advance	California.	
	" Frühe Rote "	Switzerland.	= Early Lyons.
	Big. de Jaboulay	Kent.	= Early Lyons.
	Kassin's Frühe	Germany.	
	Great Bigarreau	California.	
	Caroon	Kent.	Very similar, may be identical.
	Newington Black	Kent.	
	Strawberry Amber	Hereford.	
	Emperor Francis	Kent.	
	Black Elton	Hereford.	
	Schneider's Späte Knorpelsk.	Germany.	? correct.
	Pontiac	California.	
	" Norbury's Early Black "	Worcestershire.	Probably has another name.
	Lambert	California.	
	Noble	Kent.	
Dukes :	Hollander	Surrey.	Probably a " Duke ".
	Olivet	Kent.	
	Nouvelle Royale	Kent.	
	Belle de Choisy	France.	
Acid :	Flemish	Kent.	
	" Kentish Red "	Surrey.	" B ", said to be self sterile.

In addition to these, two years' records from White Heart (believed correctly named), indicate that it is late midseason in blossoming.

STRAWBERRIES.

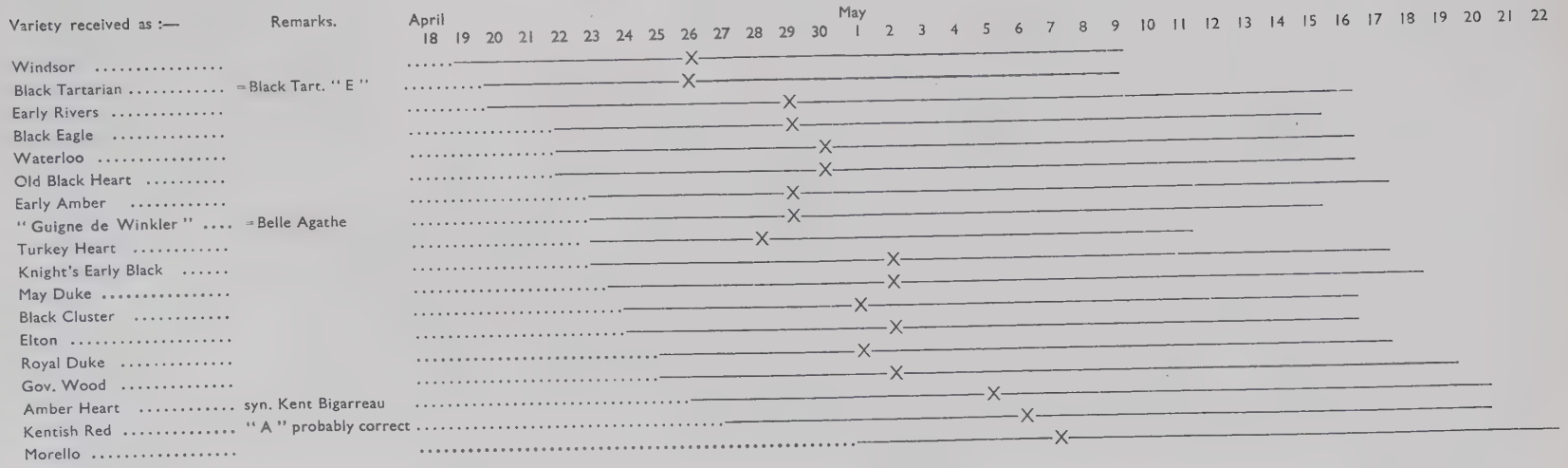
Records of time of blossoming of a number of strawberry varieties were taken on plots of 200 plants for three years, from 1930 to 1933, and are shown in Diagram 10. The average date of flowering for the whole plot was taken. All varieties flowered about

DIAGRAM 8.

BLOSSOMING PERIOD—CHERRY VARIETIES.

OLDEST TREES, PLANTED FEBRUARY, 1921. STOCKS UNKNOWN, PROBABLY ALL MAZZARD.

Average for Six Years, 1929-34 inclusive.



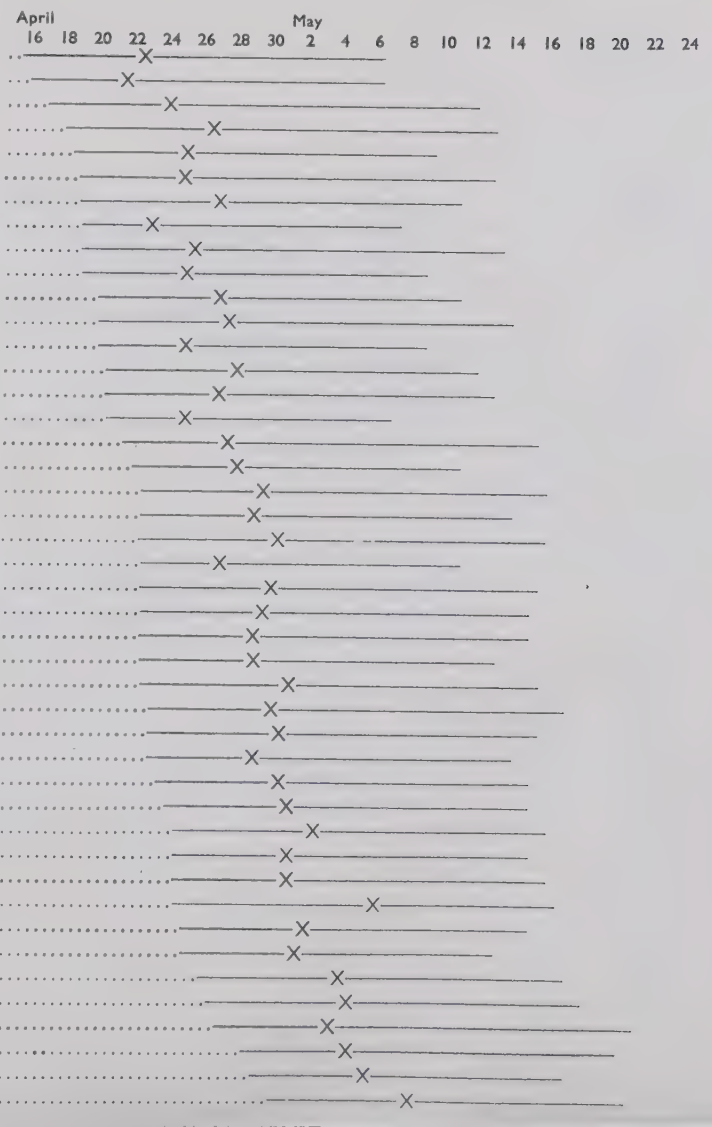
BLOSSOMING PERIOD—CHERRY VARIETIES.

DIAGRAM 9.

TREES PLANTED MARCH, 1926. Average for Four Years, 1931-4 inclusive.

Sweet Cherries.

Variety received as :—	Stock.	Source.	Remarks.
Sutton's Purple	F9/1	Kent	
Ham Green Black	2/1	Kent	
Guigne d'Annonay	5/3	Kent	
Cryall's Seedling	2/1	Kent	
Windsor	5/2	Kent	
Baumann's May	2/1	Kent	"B," said to be incorrect
"Red Turk"	1/1	Kent	May have another name
Early Cluster	5/3	Kent	
Wellington	2/1	Kent	
Noir de Guben	Unknown	Kent	
Black Tartarian	5/2	Kent	= Black Tartarian "E"
Bedford Prolific	Unknown	Bucks.	
Nutbury Black	1/1	Kent	
Cleveland Bigarreau	1/1	Kent	Not same as Early Amber
Baumann's May	5/3	Kent	"A," said to be correct
Ramon Oliva	5/2	Kent	
"Philpott's Favourite"	1/1	Kent	Probably has another name
"Napoleon Bigarreau"	1/1	Kent	Proved to be Turkey Heart
Ludwig's Bigarreau	Unknown	Kent	
Old Black Heart	5/2	Kent	
"Ohio Beauty"	5/2	Kent	Not the American variety
Turkey Heart	5/2	Kent	
Waterloo	5/2	Kent	
Black Eagle	5/2	Kent	
Early Amber	2/1	Kent	
Black Oliver	2/1	Hereford	
Circassian	9/1	Kent	
Preserving	5/3	Devon	Devonshire "Mazzard"
Norwegian	5/2	Kent	
"Guigne de Winkler"	5/2	Kent	= Belle Agathe
Knight's Early Black	5/2	Kent	
Ironsides	2/1	Hereford	Same as "Ohio Beauty" above
"Buttner's Black"	Unknown	Germany	Incorrect, white cherry
Roundel	2/1	Kent	
Dunn	5/3	Devon	Devonshire "Mazzard"
Frogmore	5/3	Kent	
Black Cluster	5/2	Kent	
Yates Seedling	5/4	Bucks.	
Victoria Black	1/1	Kent	
"Longley's Black Eagle"	5/3	Kent	Probably has another name
Planchoury	Unknown	France	
Gov. Wood	1/1	Kent	
Small Black	5/3	Devon	Devonshire "Mazzard"
Large Black	5/3	Devon	Devonshire "Mazzard"



Dukes.

Variety received as :—	Stock.	Source.	Remarks.
May Duke	F2/2	Kent	
Royal Duke	12/1	Kent	
" Belle de Franconville "	Unknown	France	Incorrect, too early ripening
Belle de Choisy	Unknown	France	
Archduke	Unknown	Bucks.	
" Belle de Chatenay "	Unknown	France	Incorrect, prob. B. de Franconv.
" Rote Mai "	Unknown	Germany	Do. do.
Ronald's Late Duke	Unknown	Kent	

Acid Cherries.

Variety received as :—	Stock.	Source.	Remarks.
Osthelmer Weichsel	F2/1	California	
Kentish Red	2/2	Kent	" A," probably correct
Wye Morello	Own roots	Kent	
Gros Gobet	Unknown	Germany	Syn. Montmorency short stalk
Morello	Various	Kent	
Coe's Carnation	Unknown	Kent	

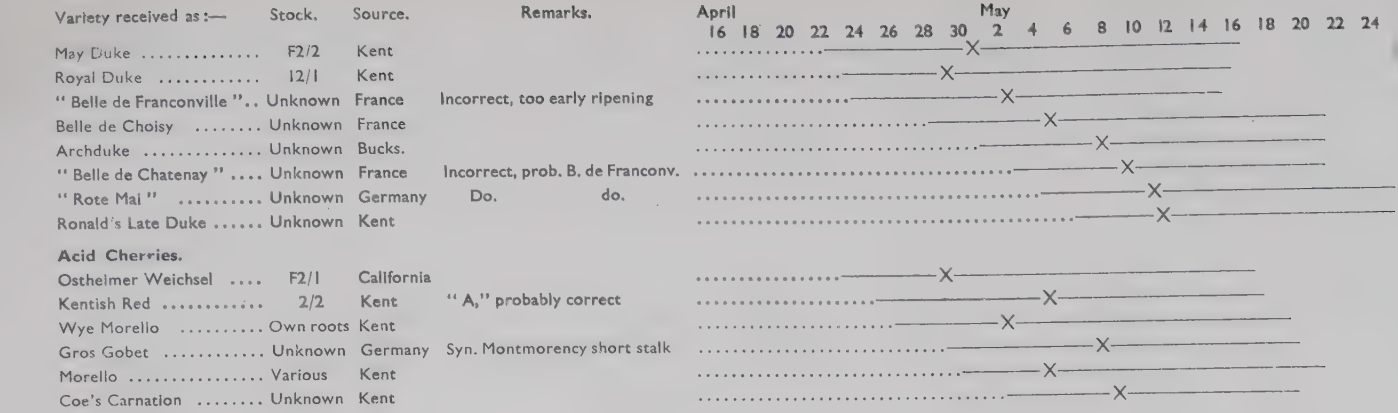
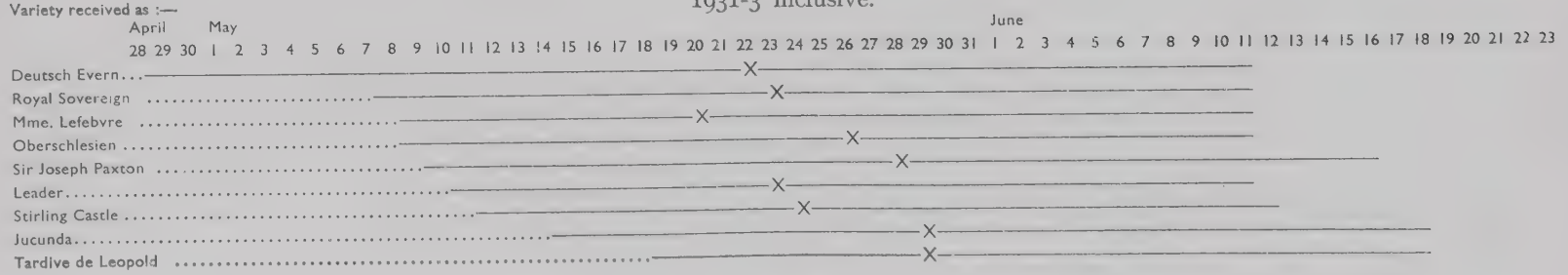


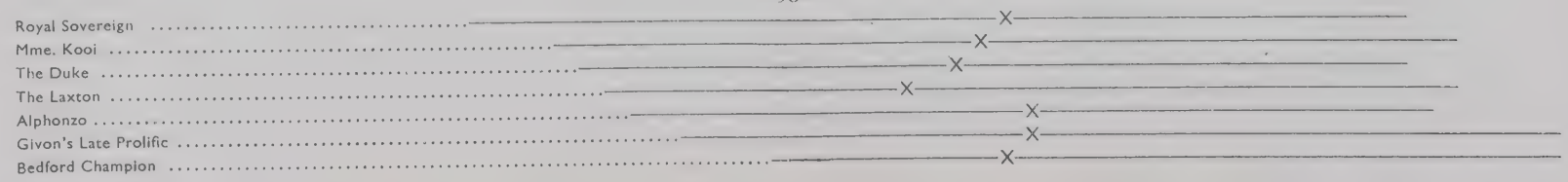
DIAGRAM 10.

BLOSSOMING PERIOD—STRAWBERRY VARIETIES.

1931-3 inclusive.


Variety received as :—
April
May
June
28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Deutsch Evern
Royal Sovereign
Mme. Lefebvre
Oberschlesien
Sir Joseph Paxton
Leader
Stirling Castle
Jucunda
Tardive de Leopold

1931-2.



three weeks earlier in 1933 than in other years, and this fact must be taken into account in comparing the time of blossoming of the six varieties which were only recorded in 1931 and 1932 with those that include all three years in the average. In order to make an accurate comparison possible, the average for the first two years of the Royal Sovereign records is included again with these varieties. The earliest date of flowering for Royal Sovereign was in 1933, when the first flower was open on 22nd April, and the plants were in full bloom on 13th May; the latest date for this variety was in 1932, when the first flower opened on 18th May and the plants were not in full bloom until 1st June. In each year Deutsch Evern was the earliest variety to open its first blossom, but Mme. Lefebvre was the earliest to come into full bloom.

Summary.

A method of recording the time of blossoming of fruit plants is described. The average dates of blossoming, over a period of years, for some varieties of apples, pears, plums, cherries and strawberries are given in the form of diagrams.

Acknowledgments.

The best thanks are due to many members of the recording staff, past and present, who have assisted in taking the records presented above, especially to the late Miss A. D. Mackenzie, Mrs. D. Akenhead, Mr. W. A. Bane and Mr. H. Olsen, who took many of the records, to Mr. W. S. Rogers for assistance with the strawberry section, and to Mr. J. Amos for helpful advice and criticism.

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APPLE ROOTSTOCKS IMMUNE FROM WOOLLY APHIS

A PROGRESS REPORT ON TRIALS WITH NEW VARIETIES

By H. M. TYDEMAN

The increasing losses sustained by fruitgrowers and nurserymen through the ravages of Woolly Aphis on apple trees, and the difficulty of finding satisfactory methods of direct control, led to the inception, in 1924, of experiments in breeding varieties of apple rootstock immune from this pest. Of the apple varieties commonly in use as resistant rootstocks by far the most general is Northern Spy. Hatton (1) has shown that, under East Malling conditions, this variety does not make so satisfactory a rootstock as the varieties of "Paradise" commonly used in this country. The "Paradise" rootstocks, on the other hand, are all more or less subject to attack by Woolly Aphis (2, 3, 4).

Throughout the earlier part of the work, crosses were made between Northern Spy and various members of the "Paradise" series in an attempt to combine the immunity of Northern Spy with the more desirable performance as rootstocks of certain of the Malling series. More recently, the work has been considerably extended and now includes a number of immune varieties such as Transparent de Croncels, Winter Majetin, etc., as well as crosses between immune seedlings selected from earlier families.

During the earlier years, the breeding work was carried out entirely by Mr. M. B. Crane of the John Innes Horticultural Institution, Merton, while the work of artificially infesting the seedlings with Woolly Aphis was undertaken by the Entomological Section at East Malling. Collaborative work between the Entomological and Biochemical Sections at East Malling on the causes underlying immunity has also been in progress for a number of years (5, 6). Later, as the work developed, the writer undertook to raise a proportion of the material required and became responsible for the pomological trials of the immune seedlings.

Since the commencement of this work in 1924, 2,300 seedlings have been raised and tested for immunity and about one-third of these have proved definitely immune. In Table I are shown those seedlings which have proved immune since the inception of the work and are now being subjected to tests as to the relative ease with which they can be propagated by vegetative means. Before it is possible to subject seedlings such as these, designed for potential new rootstocks, to exhaustive tests as to their influence on a scion variety, it is necessary that the seedlings shall be replicated by the methods of vegetative propagation, in order that sufficient numbers may be grown to overcome the effects of fortuitous variations. At the same time the ease with which a rootstock can be multiplied vegetatively is a character of considerable economic importance. It has thus become the usual procedure at this Station, in testing new varieties of rootstock, to ascertain, in the first place, whether the material will root readily when subjected to the method of vegetative propagation known as "stooling". Those seedlings which respond satisfactorily to this method are then reproduced in quantity and worked with the variety Lane's Prince Albert which serves as an indicator of their relative capacity for imparting vigour and fruitfulness to the scion.

TABLE I.

IMMUNE SEEDLINGS NOW UNDERGOING TRIAL.

Raised at Merton.		Raised at East Malling.	
Family.	No. of Immune Seedlings.	Family.	No. of Immune Seedlings.
No. I × Northern Spy (2 families) ..	57	Northern Spy × No. I (2 families)	46
Northern Spy × No. I	26	Northern Spy × No. II (2 families)	72
No. II × Northern Spy (2 families) ..	69	No. II × Northern Spy ..	26
Northern Spy × No. II (3 families) ..	32	Northern Spy × No. VIII ..	2
No. IX selfed	1	Northern Spy × No. XII ..	33
No. II selfed	2	Long Ashton 51 × Northern Spy	70
Northern Spy × Immune Seedling 789	1	Northern Spy × Reinette Zuccamaglio	17
Northern Spy × Immune Seedling 793	46	Northern Spy × Transparent de Croncels	1
Northern Spy × Immune Seedling 793	19		
Immune 789 × Immune 793	7		
Immune 793 × Immune 789	33		
Immune 793 × Northern Spy	14		

Of the numerous seedlings which have now proved immune under test, only four, from a family Spy × II, raised at Merton in 1924, have, so far, been propagated in sufficient quantity to make it possible to include them in trials worked with Lane's Prince Albert. They are Merton 778, 779, 789 and 793. The first trial of these seedlings was laid down at East Malling in 1930 and further trials in 1931 and 1932. The trees were grown in nursery rows five feet apart, the trees being about 1 ft. 6 in. apart in the rows. The method is described in detail elsewhere (7). In the case of Trial A, alternate trees were removed at the commencement of their fourth season's growth after a count of blossoms had been made. Unfortunately, owing to the difficulty of obtaining sufficient material, these trials were very incomplete. The first trial contains only Nos. 778, 789 and 793, the second only Nos. 779 and 793 and the third only Nos. 779 and 789. The first two trials were not randomized in any way and only Malling No. IX was planted as a control. The third trial was planted in randomized blocks of five or six trees and was controlled with trees worked on Malling Nos. IX, II and XII. A further, more complete trial, has now been laid out. Records of the length of wood growth made annually, the number of the blossom trusses and the number and weight of the fruits borne by the trees in these trials have now been kept for a number of years.

Small units of these seedlings have been sent out to the Argentine, Australia, Canada, India (two stations), Morocco, New Zealand (two stations), South Africa and Russia where they are undergoing entomological tests to ascertain whether their resistance to Woolly Aphis will break down under these widely differing conditions. Thus, although the results so far obtained at East Malling, as to the behaviour of these seedlings when used as rootstocks with the variety Lane's Prince Albert can only be regarded as very tentative and may have to be greatly modified as the trees grow older, the station is being so frequently asked for information as to their potentialities as rootstocks that it has been thought advisable to publish the results so far obtained. Those who are familiar with the researches being carried out at East Malling on the " Paradise " apple rootstocks will readily appreciate how unsafe it is to base predictions as to the ultimate behaviour of a rootstock on the results of a few years' observations. It should be borne in mind, therefore, when considering the results which follow, that the later behaviour of these seedlings may greatly modify any generalizations which can now be made as

to their relative influence on the vigour and precocity of the single variety with which they have so far been tried. Certain data have already been published in a previous report (7) but are repeated here in order to render this account more complete.

(*a*) Vigour as Expressed by Wood Growth and Diameter of Stem.

As may be seen from Table II, trees on the three seedlings 778, 789 and 793, included in trial A, were very similar in the amount of wood growth made annually up to their third year. They had made rather more than twice as much wood as trees on the dwarfing Malling No. IX in their second and third years. At four years old, however, there was a striking difference between trees on 793 and those on the remaining two seedlings, the latter having each made almost twice the wood growth made by the former. Thus, while trees on 793 had made about twice as much wood as trees on No. IX, trees on 778 and 789 had made about three times as much.

Of the two seedlings included in trial B, only one, 793, was represented in trial A. The trees in this trial are a year younger than those in the previous trial. So far, trees on 779 appear to be decidedly less vigorous than those on 793 although trees on both are much more vigorous than those on the dwarfing Malling No. IX.

Only two years' records have yet been obtained on the trees in trial C. Of the two seedlings included in this trial, one is included in trial A but not in trial B and the other in trial B but not in trial A. With respect to the amount of wood growth made and the diameter of the stems, trees on these two seedlings appear almost identical up to the end of their second year. They appear to be very similar in vigour to trees on the semi-dwarfing Malling No. II, coming midway between the dwarfing No. IX, on the one hand, and the very vigorous No. XII, on the other.

The figures presented in Table II indicate that 793 and possibly 779 exert a less vigorous influence over the scion variety, Lane's Prince Albert, than do either 778 or 789, after the first three or four years. It is not yet possible to assign them with certainty to any one of the four groups into which Hatton (8) has been able to separate the chief varieties of "Paradise" rootstocks, since trees for comparison on all but the most dwarfing class, have not been available until recently. The most that can be said with confidence is that trees on the four seedlings appear to be decidedly more vigorous than those on No. IX, during their earlier years at least.

(*b*) Number and Character of Blossom Trusses.

Records of the number and character of all blossom trusses formed upon the trees on these rootstocks were kept throughout and are presented in Table III. They were divided into three classes. Where they were formed at the end of long shoots they were described as terminal, on the ends of shorter growths as spur, and, where they occurred along the length of the shoots, as axillary. The trees have been left completely unpruned throughout, except in the case of trial A, when the trees were spur pruned at the end of their second year but not again. In this case the blossoms were counted before pruning.

Of the trees included in trial A, none were, on the average, anything like so prolific in blossoming as the trees on No. IX, at either three or four years old. Trees on 778 bore, on the average, considerably more blossoms in both years than either 793 or 789. Since trees on all the seedlings made a similar amount of wood growth during their second and third years these results certainly suggest that 779 may be the more prolific in blossom formation. Of the two seedlings included in trial B, little can yet be said regarding the relative amounts of blossom borne. Trees worked on them were decidedly less prolific

Table II.

Average Wood Growth and Diameter of Stem.

Northern Spy × *No. II.*

		At One Year Old.		At Two Years Old.			At Three Years Old.			At Four Years Old.		
	Number of Trees.	Wood Growth. cm.	Diameter of Stem. cm.	Wood Growth. cm.	Diameter of Stem. cm.	Number of Laterals.	Wood Growth. cm.	Diameter of Stem. cm.	Number of Laterals.	Wood Growth. cm.	Diameter of Stem. cm.	Number of Laterals.
Trial A.												
793 ..	47	109·4	1·00	607·2	2·00	17·8	1192·4	2·66	28·3	1297·2	3·66	56·4
778 ..	15	106·1	0·99	588·2	2·10	17·8	1281·4	2·85	32·1	2074·9	3·73	86·4
789 ..	28	104·3	0·94	539·0	2·04	14·4	1261·4	2·72	28·3	2223·5	4·06	84·1
Malling No. IX ..	43	99·4	0·90	233·5	1·62	10·6	542·8	2·00	21·2	722·8	2·56	32·3
Trial B.												
793 ..	16	138·0	1·14	482·3	1·89	18·0	845·7	2·87	29·8			
779 ..	23	124·3	1·11	315·7	1·78	15·8	428·2	2·50	19·2			
Malling No. IX	19	102·9	0·97	194·7	1·39	6·4	280·1	1·69	13·4			
Trial C.												
779 ..	47	134·5	1·39	752·2	2·33	25·2						
789 ..	23	139·9	1·36	752·3	2·33	23·7						
Malling No. IX	24	124·9	1·27	456·3	1·82	16·9						
Malling No. II	23	124·2	1·33	643·8	2·14	22·8						
Malling No. XII	21	148·3	1·46	1055·0	2·44	35·4						

Table III.

Average Number and Character of Blossom Trusses.

Northern Spy × *No. II.*

	At Two Years Old.				At Three Years Old.				At Four Years Old.			
	Terminal.	Axillary.	Spur.	Total.	Terminal.	Axillary.	Spur.	Total.	Terminal.	Axillary.	Spur.	Total.
Trial A.												
793 ..	0	0	0·1	0·1	0·5	1·0	10·5	12·0	7·0	13·6	5·5	26·1
778 ..	0	0	0·1	0·1	0·3	2·8	16·2	19·3	10·7	23·7	10·8	45·2
789 ..	0	0	0	0	0·4	1·0	9·0	10·4	7·4	10·0	10·0	27·4
Malling No. IX	0·02	3·7	0·3	4·0	1·2	17·2	31·1	49·5	7·5	28·2	33·5	69·2
Trial B.												
793 ..	0	0·2	0	0·2	5·4	10·4	16·0	31·8				
779 ..	0	0·3	0	0·3	1·6	2·0	14·0	17·6				
Malling No. IX	0	13·2	0	13·2	3·8	32·7	23·0	59·5				
Trial C.												
779 ..	0·05	1·7	0	1·7								
789 ..	0·1	4·9	0·4	5·4								
Malling No. IX	0·6	13·0	0·8	14·4								
Malling No. II ..	0·3	7·1	0·5	7·9								
Malling No. XII	0·2	0	0	0·2								

Table IV.

Average Number and Weight of Fruits.

Northern Spy × *No. II.*

	At Two Years Old.			At Three Years Old.			At Four Years Old.		
	Number of Fruits.	Weight ozs.	Average Weight per fruit.	Number of Fruits.	Weight ozs.	Average Weight per fruit.	Number of Fruits.	Weight ozs.	Average Weight per fruit.
Trial A.									
793	0	0	0	2·4	13·0	5·3	3·0	16·0	5·3
778	0	0	0	6·0	25·3	4·2	3·5	16·0	4·5
789	0	0	0	3·5	20·1	5·6	3·5	16·1	4·6
Malling No. IX	0·4	2·5	6·2	5·5	29·3	5·3	13·9	72·2	5·2
Trial B.									
793	0	0	0	4·9	20·6	4·2			
779	0	0	0	1·9	5·3	2·7			
Malling No. IX	2·0	8·4	4·2	4·5	20·5	4·5			
Trial C. ..									
779	0·02	0·03	1·5						
789	0·11	0·5	4·5						
Malling No. IX	3·4	16·0	4·7						
Malling No. II	1·0	4·0	4·0						
Malling No. XII	0	0	0						

than trees on No. IX at both two and three years old. The results at three years old suggest that 779 may be somewhat less free blossoming than either 793 or 789 if the single year's records from trial C are any indication.

It is somewhat difficult to arrive at any satisfactory conclusion as to the relative freedom of blossoming of trees on these four immune rootstocks from the data available ; this is due in part to the incompleteness of the trials and in part to the short period over which the records are available. The data leave little room to doubt that these immune rootstocks are decidedly less precocious in their influence over the scion, than Malling No. IX and there are indications that 778 may be somewhat more free blossoming than either 793 or 789, at least up to its fourth year.

(*c*) Number and Weight of Fruits.

The number and weight of fruits borne by trees on these rootstocks was recorded during each year. The results are summarized in Table IV. As may be seen, practically no fruit was borne by any of the trees until they were three years old. At that age, 778 in trial A and 793 in trial B both produced more fruits, on the average, than the control trees on No. IX. In general, a fairly close correlation can be traced between the number of blossoms borne and the number of fruits which matured. Thus, in trial A, at four years old, trees on 778 set, on the average, one fruit to 12·9 blossom trusses ; on 793 one fruit to 8·7 blossom trusses ; on 789, one fruit to 7·8 blossom trusses, while trees on No. IX set one fruit to each 4·9 blossom trusses borne. In trial B, at three years old, 793 bore, on the average, considerably more fruits than did 779.

It is not possible so far to say much as to the relative fruitfulness of trees on these rootstocks, when worked with Lane's Prince Albert. At four years old trees on 793, 778 and 789, included in trial A, bore about one-quarter of the fruit borne by trees on No. IX and it seems fairly safe to conclude that trees on all these seedlings are less productive in their early years than trees on the precocious Jaune de Metz.

As may be seen from the foregoing, the work of testing these four immune seedling rootstocks is, as yet, far from complete and is being continued.

While it has fallen to the lot of the writer to prepare this report, the work outlined therein is being carried on by a considerable team of collaborators. The inception of the work was due to the Director, Mr. R. G. Hatton, and he has continued to supervise it throughout its progress. Mr. M. B. Crane of the John Innes Horticultural Institution was mainly responsible for providing the seedlings for testing. The Entomological work has been carried out at various times by Messrs. L. N. Staniland, R. Le Pelly, A. M. Massee and R. M. Greenslade. The task of propagating and preparing the material for the various trials has been carried out by the Propagation Section, first under the direction of Mr. A. W. Witt and later under that of Mr. R. J. Garner while Mr. T. N. Hoblyn has been responsible for the planning and layout of the later trials.

Summary.

This paper briefly describes the work of raising new varieties of apple rootstock immune from Woolly Aphis. Details of the vigour as expressed by wood growth and diameter of stem and the productivity as expressed by the number of blossoms and fruits produced, of trees of Lane's Prince Albert worked on four immune seedling rootstocks, Merton 778, 779, 789 and 793, from a family of Northern Spy × Malling No. II (Doucin) are summarized and discussed. Under the conditions of these trials they proved definitely more vigorous in their influence over the scion than Malling No. IX and less productive

both of blossoms and fruit in their early years. Results, so far obtained, suggest that two of the seedlings, 793 and 779, are less vigorous in their influence over the scion variety than either 778 or 789.

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STUDIES IN NURSERY TECHNIQUE

SHIELD-BUDDING—THE REMOVAL OF THE WOOD

A PROGRESS REPORT

By R. J. GARNER

THE operation known as " shield-budding " is probably by far the most common method of uniting scion varieties with rootstocks in fruit-tree nurseries. Descriptions of the procedure have been given from time to time (1, 2, 5) and, though these vary considerably with regard to technique, all involve the removal of at least a thin portion of wood along with the bud cut from the scion variety prior to its insertion in the rootstock.

It has been the custom in this country, and on the Continent, to remove the wood from the bud shield before insertion. The removal of the wood is described and advocated in various textbooks written for the English fruitgrower (2, 3) though the operator is warned that there is risk of injury to the delicate base of the bud in so doing. On the other hand the majority of the American authorities (4, 5, 6) assert that the presence of the wood in the bud shield of deciduous fruits has no adverse effect and it is the common practice in the United States and Canada to leave the wood attached to the bud shield.

Seeing that the removal of the wood requires time and skill, moreover that there is some risk of injury to the bud, it appears likely that the practice of removing the wood might be given up in this country as in America, if operators were convinced that equally good results could be obtained. It should be pointed out that in practice when it is not intended to remove the wood, it is found advantageous to cut the bud shield quite thin. This facilitates the entry of the bud beneath the rind of the rootstock and ensures close contact between the cut surface of the bud and the rootstock.

From time to time at East Malling during the period 1919-31 it was found necessary to insert buds of apple, pear and plum with the wood attached because the condition of the scion variety prevented the removal of the wood without injury to the bud. These buds invariably gave rise to the normal proportion of good maiden trees. During this period a few small scale experiments were made, but it was not until 1932 that any larger scale trials were laid down for the express purpose of testing the effect of leaving the wood in, against its removal from the bud shield.

In 1932 one budding trial was carried out in which Lane's Prince Albert was budded on to eleven different rootstocks. The rootstocks were planted in fifty-five plots of ten stocks each in such a manner that differences due to soil variation could be estimated and eliminated. In 1933 a further trial using the apple rootstocks Nos. II, IV, VII and IX and the scion varieties Cox's Orange Pippin and Worcester Pearmain was laid down. Similar trials with pears, plums and cherries were carried out in the same season.

Records were taken of the " bud take " in the spring, the time of " bud break " and the height of the tree at the end of the first season's growth. In the case of the plum budding trial the diameter of the swelling at the point of union was measured by means of graduated calipers with a view to ascertaining any differential effect in the extent of the " bulge " at the union due to the treatment of the buds.

Maiden Trees.

Mean Height per Tree in cm.

Year Budded.	Class of Fruit.	Total Number Budded.	Varieties.	Stocks.	Treatments.				General Mean.	Significant difference.
					Wood left in. Height.	% Success.	Wood removed. Height.	% Success.		
1932	Apple.	*548*	Lane's Prince Albert.	Layers from Seedlings of VIII × IX (eleven selections).	114·8	*90·2*	112·0	*90·8*	113·4	4·2
1933	Apple.	*768*	Cox's Orange Pippin. Worcester Pearmain.	Nos. II, IV, VII and IX.	104·6	*77·8*	103·6	*82·3*	104·1	5·2
1933	Pear.	*768*	Doyenne du Comice. Conference Beurre Hardy. Williams bon Chretien.	Quince A.	117·8	*95·3*	116·7	*95·5*	117·2	2·9
1933	Pear.	*768*	Ditto.	Quince C.	114·9	*96·3*	112·7	*98·7*	113·7	3·4
1933	Plum.	*240*	Pershore Egg.	Pershore. Common Mussel. Common Plum.	201·9	*85·0*	204·7	*89·1*	203·3	18·1
1933	Cherry.	*160*	Morello.	Mazzard (P. avium) (Selection F2–1).	102·7	*78·7*	104·7	*90·0*	103·7	10·3

In the last column is shown the difference necessary between the average heights of each treatment to give a statistically significant result.

Autumn Start.

Apart from the apple budding trial carried out during the summer of 1932, the number of buds which grew out from the time of insertion until the end of the growing season was too small to show any differential effect due to treatment. In this trial in which a considerable number of buds grew out during the autumn, twelve of the 275 buds inserted with the wood and twenty-five of the 273 buds inserted after removal of the wood, grew out before the dormant season. Statistical analysis shows this difference to be just significant. Until these results are confirmed by further trials it would be unwise to attach too much importance to the figures obtained from this one trial; nevertheless, care will be taken to follow up this point in trials now under way and in the future.

Bud Take.

A statistical examination of the records shows that when the five separate trials are taken as a whole the number of maidens produced from buds inserted after removal of the wood is just significantly greater than the number produced from those inserted with the wood. Though this fact must not be entirely ignored it should be emphasized that the difference is very small (about 3 per cent.) and unlikely to be of economic importance. Even so, particular attention will be directed to this aspect in future trials. Once a bud was recorded as having " taken " it always grew out into a normal maiden tree, except for a very few occasional accidents which were accounted for. The numbers of maiden trees produced are shown in the table.

The measurements of the heights of the trees at the end of the growing season are summarized in the table. It will be seen that there are no significant differences in any of the five trials.

The measurement of the cross-section of the widest part of the union of the maiden plum trees, budded in 1933, failed to reveal any significant difference between trees under the two treatments.

It is therefore safe to say, in view of the results of these trials, that there is no reason to believe that there will be any adverse effect on the production of trees, due to the insertion of buds without removing the wood. This being so, it is not unreasonable to suggest that this practice might be adopted in this country as in America. The advantages, from the tree-raiser's point of view, lie in the economy of time and the saving of buds that had formerly to be discarded owing to their being damaged during the removal of the wood. To the amateur, who generally finds the removal of the wood the most difficult detail in the operation of budding, the knowledge that he can with confidence leave the wood in the bud shield of apples, pears, plums and cherries, should be a very real help.

Thanks are due to Miss B. M. Wates for summarizing the records and to Mr. T. N. Hoblyn for planning the layout of the trials and for the statistical examination of the records.

Summary.

Attention is drawn to the fact that in the operation of shield-budding, as generally practised in England, the wood is removed, whereas in America it is left attached to the bud shield.

Details of trials on 3,252 apple, pear, plum and cherry buddings are given which show that there is no marked difference between trees raised by the one and by the other method.

Mention is made of the economic advantage of the method involving the retention of the wood.

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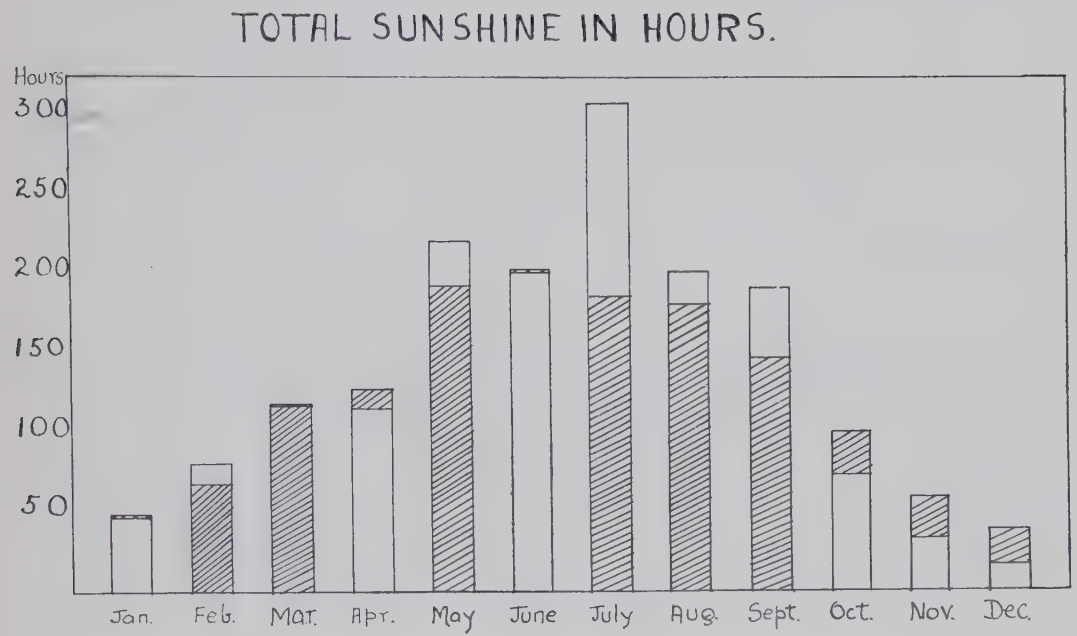
WEATHER CONDITIONS DURING 1934

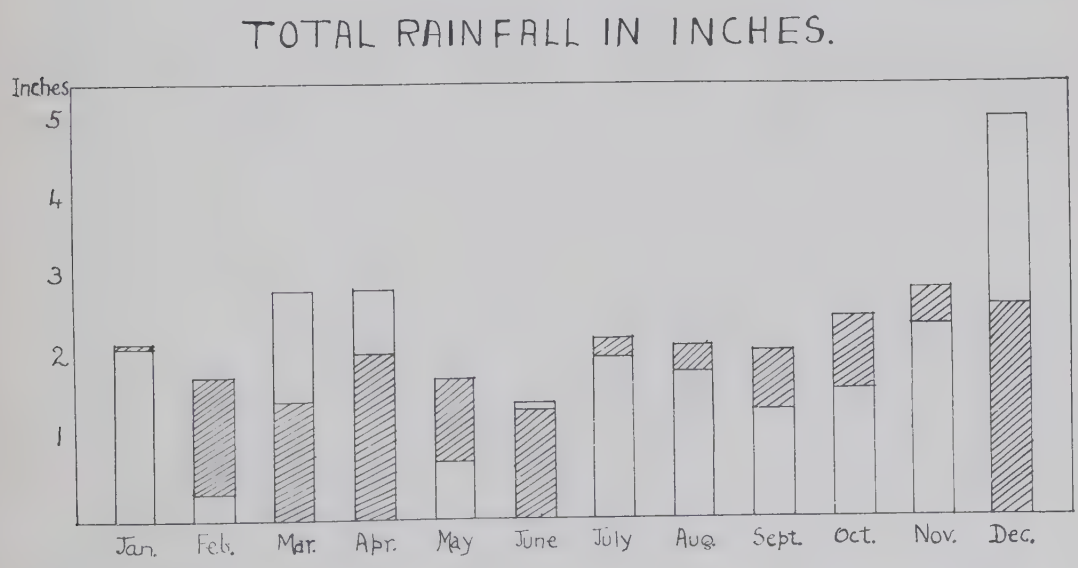
By H. C. CHAPELOW AND H. M. TYDEMAN

LOOKED at from the point of view of the horticulturist, the weather conditions experienced in this locality throughout 1934 were fairly satisfactory. The weather during the blossoming of all varieties of fruit was good, periods of severe frost being completely absent. Conditions throughout the earlier part of the year were somewhat dry, due in part to the very dry conditions experienced during the latter part of 1933. While the rainfall recorded during February was notably small, only about one-sixth of the average for the month, considerably more than the average quantity fell during both March and April. Thereafter, until the end of November, the rainfall was below average, the defect amounting to just over 3 inches by that date. December's rainfall, however, was so heavy that the deficiency was made up by the end of the year except for a fractional part of an inch. The total rainfall for the year amounted to 24·73 inches, while the average annual rainfall at this Station during the past nineteen years was 25·39 inches. The sun shone for 1,596·4 hours and on 281 days during the year. This was 113·6 hours more than the nineteen years' average here. The whole of this excess occurred during July which, with 300·9 hours sunshine, was one of the sunniest Julys upon record here. Sunshine was somewhat scanty during October, November and December. Temperatures ranged somewhat low during the early spring and again during the late summer and autumn but were otherwise about average.

SUMMARY OF METEOROLOGICAL OBSERVATIONS DURING 1934.

	Temperature in Screen.					No. of Ground Frosts.	Rainfall.			Sunshine.			Soil Temperatures.		
	Mean Maximum.	Mean Minimum.	Highest.	Lowest.	Mean.		Total in inches.	19 years' average.	Heaviest fall in a day.	Total hours.	19 years' average.	Average per day.	4 inches.	8 inches.	2 feet.
January ..	44·3	32·4	53	21	38·3	21	2·17	2·21	0·55	45·4	48·5	1·5	37·1	37·6	39·1
February ..	40·9	30·7	52	20	35·8	24	0·32	1·80	0·26	81·0	68·7	2·9	35·3	36·2	38·2
March ..	49·0	33·5	53	23	41·2	18	2·86	1·50	0·42	119·7	119·3	3·8	39·1	39·7	41·4
April ..	55·4	39·3	75	27	47·3	8	2·87	2·09	0·61	116·0	128·1	3·9	46·3	45·9	46·3
May ..	63·0	42·7	75	33	52·8	2	0·71	1·78	0·32	221·4	194·7	7·1	54·8	53·9	54·0
June ..	68·8	48·3	85	36	58·5	0	1·48	1·39	1·00	200·4	201·0	6·7	61·7	60·8	60·5
July ..	75·4	51·2	85	43	63·3	0	2·02	2·26	1·02	300·9	186·2	9·7	65·8	64·8	65·1
August ..	70·1	48·7	80	35	59·4	0	1·83	2·18	0·52	202·7	182·4	6·5	61·5	61·4	63·1
September ..	69·3	46·6	82	36	57·9	0	1·38	2·10	0·54	192·3	148·2	6·4	58·0	58·4	60·1
October ..	58·1	43·2	64	33	50·6	7	1·61	2·52	0·52	70·9	101·0	2·3	51·9	52·0	54·9
November ..	47·2	36·3	54	26	41·8	14	2·41	2·89	0·85	30·6	55·8	1·0	42·9	43·6	45·8
December ..	51·7	41·3	56	32	46·5	4	5·07	2·67	0·63	15·1	38·9	0·5	45·0	45·7	46·9





Diagrams showing Total Sunshine and Rainfall during 1934 as compared with 18 years average. Shaded portion 18 years average.

STATISTICS AND RECORDS

AN EXPERIMENT IN SAMPLING TECHNIQUE FOR SIZE AND COLOUR OF APPLES

BRAMLEY'S SEEDLING ON ROOTSTOCK NO. II 1934 CROP

By J. L. EDGAR AND A. F. DE WET

IT is important that records of size and colour grading should be obtained from the fruit crops of experimental orchard trees, especially in the case of manurial trials. This grading of the crop of each whole tree is necessarily a lengthy process, which frequently entails the separation of the crop into seventy-two different categories, and where market qualities have also to be considered, into as many as 216. Where the crops are very large this is often impossible to do in full on more than a few trees; further, outside factors may tend to bias the results. It has been found that the intensity of the colour may change if the fruit is left for any length of time, and it is therefore desirable to reduce to a minimum the time taken in grading and recording. With this object in view, an experiment in sampling technique on Bramley's Seedling apples was carried out. Eight fifteen-year-old trees on rootstock No. II were chosen in October, 1934, these being part of an experiment in the nitrogenous manuring of trees under grass.

The fruit was picked into orchard boxes, each containing about 40 lbs., and each one was labelled with the row and tree number, and also the number of the box in the order in which they were stacked. Each box of fruit was then graded on the ring grader into six size grades, each grade placed in a chip basket which was labelled with the tree number, box number and size grade. Each basket was then graded for amount and intensity of colour in the usual way into twelve grades (1), after which the fruit was well mixed up, and put back into the original boxes from whence it came.

When all the original boxes had been graded in this manner—about eight boxes per tree, sixty-eight in all—eight " sample " boxes were taken from each tree. Each " sample " box was filled by taking an equal number of apples at random from each original box, and contained about 120 apples. Thus, if there were eight original boxes, the " sample " boxes were filled by taking fifteen apples from the top of each of these to fill the first " sample " box, and continuing in this way until there were eight " sample " boxes. If it was possible for only seven, or six, full " sample " boxes to be taken, the remainder of the fruit was discarded.

The " sample " boxes were then graded for size and colour in the same way as for the original boxes.

The grading of the original boxes was carried out on the 10th and 11th October, 1934, and the " sample " boxes from the 12th-15th October, 1934.

SUMMARIZING OF RESULTS.

The number of apples in each size and colour grade was calculated and tabulated for each original and " sample " box. " Size figures " for each box were obtained by multiplying the number of apples in each size grade by the grade number, i.e. if there

were twenty apples in grade 2, the contribution from that grade would be forty, adding these together, and dividing by the total number of apples in the box. The resulting figure is the mean size grade of all the fruit in the box. This was calculated for all original and " sample " boxes.

The " colour figure " for each box was also calculated by first multiplying the number of fruit in the colour grade by the intensity figure for that particular grade, and then by the figure for the amount of colour. Thus, if there were seven apples more than half coloured (amount two), and of the lowest intensity (intensity three), the contribution would be $7 \times 2 \times 3 = 42$. These were added together and divided by the total number of apples, giving the " colour " figure of the tree (2).

In both cases, therefore, the " figures " for the largest and best coloured fruits are the lowest.

While the grading was in process it was noticed that the " sample " boxes appeared more highly coloured than the original boxes ; this was due to the fact that the original boxes which had been graded were standing in a rather warm place for two or three days. In order to find out whether this increase was due to a deepening of the intensity or an increase in the actual amount, colour figures for the intensity alone, and for the amount alone, were calculated for the " sample " boxes, and also for the original box figures adjusted so that the total number of fruits per tree was the same as the total number of fruit taken for the " sample " boxes. These figures could then be compared, and showed that the colour had both deepened in intensity, and increased in amount during the time which elapsed between the two gradings. This was probably due to the green ground colour becoming yellower and making the red colour seem deeper, and the amount of colour more. These figures are tabulated in Table I.

TABLE I.

BRAMLEY'S SEEDLING ON II. COLOUR GRADING. AMOUNT AND INTENSITY FIGURES PER TREE FOR " SAMPLE " BOXES (1) AND ORIGINAL BOXES ADJUSTED (2).

Amount Figures.		Intensity Figures.	
(1)	(2)	(1)	(2)
2·77	2·80	2·52	2·68
2·83	2·91	2·72	2·77
2·03	2·36	2·31	2·45
2·22	2·33	2·30	2·47
3·40	3·43	2·96	2·98
3·30	3·49	2·97	2·98
3·14	3·34	2·91	2·95
3·15	3·16	2·86	2·94
Mean 2·85	2·98	2·69	2·78

(1) " Sample " boxes graded 12th and 15th October, 1934.
(2) Original boxes graded 10th and 11th October, 1934.

ANALYSES.

The colour figures for the original boxes and for the " sample " boxes were analysed in such a way that a value could be obtained for the variation of the colour and size figures between the boxes making up each tree, but eliminating the variation between trees. This is known as the coefficient of variability (V) and is the standard deviation

expressed as a percentage of the mean. The variation between trees was eliminated on account of the two different manurial treatments, with which this experiment is not concerned.

Coefficients of variability were calculated in the same way for the size figures.

The next step was to combine the boxes in pairs at random, and to recalculate the " size " and " colour figures " for this larger sample. This was done with both the original and " sample " boxes, and coefficients of variability were again calculated.

The boxes were finally combined in threes at random to discover what reduction in the coefficients of variability resulted. The figures for size only were analysed in this case.

Conclusions.

Both in size and colour the original boxes vary very much more from box to box than the sample boxes, which fact may be easily explained. The fruit on one side of the tree—or on one particular branch—may be smaller, or less coloured than on other parts of the tree, and this is naturally all picked into one box. There is often a tendency on the part of the pickers to pick the most highly coloured fruit first. It would thus seem a highly dangerous procedure to take as a sample a single box as picked from the tree. In the " sample " boxes the fruit is mixed up, and is more representative of the fruit on the whole tree. The colour figures vary a little more than the size figures for the original boxes. Colour is influenced by shading and the position on the tree; these factors probably do not affect size.

The values for V are given in Table II.

Table II.

Bramley's Seedlings on II. Colour Grading. Coefficients of Variability (V).

	V.	
	For Colour Figs.	For Size Figs.
Original Boxes singly	11·1	9·6
" Sample " Boxes singly	4·9	5·6
Original Boxes taken in Pairs ..	8·1	7·8
" Sample " Boxes taken in Pairs	4·1	3·2
Original Boxes taken in Threes ..	—	4·9
" Sample " Boxes taken in Threes	—	3·0

When the boxes are combined in pairs at random the coefficients of variability are reduced. In the case of the colour figures for the original boxes taken singly V = 11 per cent.; when the boxes are combined in pairs, this is reduced to 8 per cent. V for the colour figures of " sample " boxes taken singly is about 5 per cent., this being reduced to 4·1 per cent. when they are combined in pairs.

With size figures there is a corresponding reduction in the coefficient of variability.

When the boxes are combined in threes at random, and the size figures analysed, it is found that V for the original boxes is about 5 per cent.—a reduction of 2·8 per cent.

on the combination in pairs, whereas for the " sample " boxes it is only reduced by 0·25 per cent.

It may be noted that about the same accuracy is obtained by taking one " sample " box as by taking three of the original boxes.

It therefore seems that the " sample " boxes are sufficiently uniform to take as representative of the total crop of the tree. By taking two " sample " boxes in the way described, and combining them, about 25 per cent. of the total crop is graded, and labour and time reduced proportionately.

The amount of time taken over colour grading is an important factor, as has been shown in Table I. In a very short time the colour may increase considerably in both amount and intensity, and this source of error may be eliminated to some extent by means of a sampling technique.

Of the eight Bramley's Seedling trees used for this experiment, four had been unmanured, and four manured with nitro-chalk. The size and colour figures for the total crops were analysed, comparing no nitrogen versus nitrogen, and standard errors were calculated. The same analysis was carried out by taking a single sample at random for each tree from the original boxes, then by taking a single sample at random from the " sample " boxes, and finally by taking two samples and combining them. The results of these analyses are shown in Table III.

TABLE III.

Colour Figs. Means per Tree.	Whole Crop.	Single Original Box at random		Single " Sample " box at random.	Random pair original boxes.	Random pair " Sample " boxes.
		First sample.	Second sample.			
Nil	7·02	7·09	5·93	6·60	6·71	6·77
N/C.	9·96	10·19	10·27	9·51	9·78	9·69
S.E.	*0·45*	*0·49*	*1·09*	*0·62*	*0·54*	*0·50*
Sig. Diff. ..	*1·54*	*1·69*	*2·67*	*2·15*	*1·88*	*1·74*
Size Figures.						
Nil	3·25	3·31	3·33	3·20	3·03	3·21
N/C.	3·16	2·99	3·01	3·04	3·28	3·11
S.E.	*0·12*	*0·14*	*0·34*	*0·27*	*0·16*	*0·18*
Sig. Diff. ..	*0·43*	*0·47*	*0·84*	*0·67*	*0·54*	*0·62*

In the first column the mean size and colour figures for the whole crop are tabulated, showing the significant differences. This difference is highly significant where colour is concerned, but there is no difference between the two manurial treatments in mean size. The second and third columns show the results obtained by analysing the size and colour figures of single original boxes taken at random from each tree. The first sample gave a result which had a smaller standard error than that for the " sample " boxes taken singly at random, and the mean values for the two treatments approximated very closely to those for the whole crop. This was due to the uniformity of the boxes which happened to be included in that random sample. To show that this was entirely due to chance, a second random sample of single original boxes was taken. The results of the analysis

of this set of values are tabulated in the third column, and it may be seen that the standard error of this sample is greater than that of the rest, both for size and colour. The results of these two samples further illustrate the variability of the fruit in the original orchard boxes.

Where the difference in colour is obviously a large one, one " sample " box would be sufficient to show this difference, but in cases where the differences are not so large, it would be necessary to increase the size of the sample in order to obtain the colour and size figures with greater accuracy.

Acknowledgment.

The writers are greatly indebted to Mr. T. N. Hoblyn for suggesting the experiment, and also for advice on the analysis of the results.

Summary.

1. The crop of eight trees of Bramley's Seedling on II was graded for size and colour, taking each orchard box separately.

2. " Sample " boxes were then taken from the total crop for each tree, and these were graded separately for size and colour.

3. It is found that the " sample " boxes are sufficiently uniform to take one as representative of the crop of the whole tree. The same degree of accuracy is obtained by grading one " sample " box as by grading three of the original orchard boxes.

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BIOCHEMISTRY

TREE INJECTION—INVIGORATION BY THE INJECTION OF FERTILIZERS

A PROGRESS REPORT

By W. A. ROACH

The general aims of this investigation were indicated in this Report last year and some of the results already obtained were mentioned (3). This note describes a first attempt to test the tree injection method on a larger scale in a commercial plantation.

Experimental Material.

The trees used for the experiment were of variety Cox's Orange Pippin ; they were twenty-one-year-old bush trees planted 12 ft. apart, and they just "filled" this space. In the autumn of 1934 the whole plantation was lacking in vigour ; consequently the very heavy growth of weeds was "disced in" and a dressing of 4 cwt. per acre of sulphate of potash applied to the whole plantation. Following this remedial treatment, the trees grew so vigorously as to make them hardly suitable for the present experiment. Further, the trees were not all worked on the same rootstock and were very variable. This high general level of vigour of the trees and their variability would both tend to mask any effect of injections designed to increase vigour ; but, as will be seen later, marked increase in vigour resulting from injection was apparent, in spite of this.

After rejecting the most uneven trees, the remainder were divided into groups of three ; one of each group was injected with fertilizer, one with water and the third one remained untreated. The treatments were arranged at random within each group.

The Fertilizer.

The solution injected contained 0·25 per cent. potassium phosphate (K_2HPO_4) plus 0·25 per cent. urea ; this would supply the three major elements necessary for growth in forms which, though not used commercially as fertilizers at present, could be produced at a suitable price. The above compounds were used in preference to the commercial fertilizers at this stage in order to avoid all risk of direct injury to the trees. Urea supplies about twice as much nitrogen as an equal weight of sulphate of ammonia and is more easily utilized by the plant. The trees were injected early in June through a single hole $\frac{1}{4}$ inch in diameter drilled diametrically through the main stem ; the method has already been described (3).

Amount Injected. Little guidance could be obtained either from the literature or from the writer's past experience as to the best quantity of fertilizer to inject. It was decided, therefore, to allow the trees to absorb until the first sign of leaf damage showed itself on any tree, then to stop all the trees absorbing. As a result, the eight trees varied considerably in the amounts which they absorbed.

RESULTS.

(i) *Shoot Growth.* It will be convenient to consider the effect of the injection on shoot growth first. The weight and number of current year shoots removed in pruning were taken as a measure of shoot growth.

TABLE I.

WEIGHT AND NUMBER OF CURRENT-YEAR SHOOTS REMOVED IN PRUNING.
Fertilizer—Injected and Uninjected Trees.

Lbs. per acre of Fertilizer.	Weight of Prunings from		Ratio Fert. Inj'td. / Uninjected.	Number of Prunings from		Ratio Fert. Inj'td. / Uninjected.
	Fertilizer Injected Trees.	Uninjected Trees.		Fertilizer Injected Trees.	Uninjected. Trees.	
50	5·3	1·45	3·65	548	200	2·8
32	3·5	2·1	1·7	385	197	1·9
27	6·1	1·45	4·2	564	149	3·7
27	5·85	2·7	2·2	526	233	2·25
22	3·9	2·1	1·9	426	251	1·7
20	3·9	3·0	1·3	353	215	1·6
12	4·0	3·6	1·1	335	346	1·0
10	2·3	2·1	1·1	257	205	1·25
Totals	34·85	18·5	1·9	3,373	1,796	1·9

In the above table the results are arranged in decreasing order of the amount of fertilizer absorbed by the injected trees, the result for the corresponding injected and uninjected trees being placed side by side. The amount of fertilizer has been calculated on an acreage basis ; thus if all the trees had been injected at the same rate as the one coming first in the table, 50 lbs. of potassium phosphate plus 50 lbs. of urea would have been injected per acre of plantation ; the actual amount absorbed by this tree was 75 grams or $\frac{1}{6}$ lb. of each substance. This was dissolved in $6\frac{1}{2}$ gallons of water. The solution was absorbed in less than six days.

Photographs of the prunings from the injected and uninjected trees taken under exactly similar conditions are reproduced in Plate facing p. 138. The bundles from the injected trees have on them numbers representing the amounts of fertilizer injected in lbs. per acre. Bundles from contiguous injected and uninjected trees are placed the one below the other.

It will be seen that the greater the amount of fertilizer absorbed the more did the weight and number of prunings from the fertilizer injected tree exceed those from the corresponding uninjected one. The total prunings from all the fertilizer injected trees were 1·9 times (or nearly twice) as heavy and as numerous as those from the uninjected trees.

(ii) *Foliage.* A number of skilled and unbiased observers were asked to report on the foliage of the trees in groups of three after the fruit had been gathered. All of them reported the fertilizer injected tree as the best in six of the eight groups. In the remaining two groups they hesitated and about half chose the fertilizer injected tree and half the water injected or uninjected tree. These two groups of trees were the ones occurring at

the bottom of the table, namely those in which the fertilizer injected tree absorbed the least amount of fertilizer. The effect of this small amount (10 or 12 lbs. per acre) was too little to swamp the large variation from tree to tree.

(iii) *Pests.* Mr. A. M. Massee made the valuable observation that the six trees absorbing at the rate of 20 lbs. per acre and over not only had foliage of a healthier green than the uninjected trees but that this healthier foliage was much less heavily infested by Apple Leaf Hopper and Fruit Tree Red Spider than that of the uninjected trees, the infestation of which was, in his opinion, sufficiently great to account for its unhealthy appearance. It may be mentioned here that Andrews (1) succeeded in rendering tea bushes immune from attack by an insect by injecting potash salts.

(iv) *Size of Crop.* The variation in crop from tree to tree independent of treatment was so great as to make unreliable any deduction as to the effect of treatment on total crop.

(v) *Quality of Crop.* Just before and just after picking, the fruit from all the six trees absorbing the larger amounts of fertilizer was inferior in regard to colour and finish than that from the water injected and the uninjected trees. Since it was only after analysis of the results that this clear cut difference was realized, the behaviour of the fruit in storage was not followed. It is uncertain, therefore, whether the difference was one of actual quality or of maturity.

Effect Uniform throughout the Branches of a Tree.

Perhaps the most striking character of the fertilizer injected trees was the uniformity with which all the branches of the trees were invigorated. This was in marked contrast with the effect of the general remedial treatment (incorporation of weeds with soil and sulphate of potash dressing); on almost every tree one or more branches remained unaffected and the remainder were affected one more than another. But for the fear of this variation from branch to branch of the same tree the trees would have been so injected that each branch received a different mixture and a comparison made of a number of fertilizers.

Effect of Water Injection.

The weight of prunings from the water injected trees exceeded that of the prunings from the uninjected ones by 23 per cent., suggesting a beneficial effect; but the variation from tree to tree was too great to allow of any conclusion being based on this fact.

Conclusions.

The above experiments have proved that it is possible to bring about by the injection of a suitable fertilizer a beneficial effect on the tree as great as that produced by the more usual method of applying fertilizer to the soil; and there need be no risk of any ill effect on the tree (4). The injection was carried out in June, at which time any fertilizer application to the soil, because of the lack of rain to wash it in, would have been quite without effect until the following season.

Further experiments are justified to test the possibilities already suggested (2, 3) of using tree injection as a means of diagnosing mineral deficiency in the plantation and in certain special cases of actually curing whole plantations by injection.

Acknowledgments.

It is a pleasure to acknowledge much help and kindly criticism, especially from those who made expert reports on the growing trees. The photograph from which the plate was reproduced was taken by Mr. R. M. Greenslade. A special debt of gratitude is due to Mr. W. Ferwerda, who gave invaluable assistance in carrying out much of the practical work.

Summary.

1. Cox's Orange Pippin apple trees in a commercial plantation were injected with a "complete fertilizer" solution containing 0·25 per cent. potassium phosphate (K_2HPO_4) plus 0·25 per cent. urea at rates which varied from $\frac{1}{30}$ to $\frac{1}{6}$ lb. per tree or from 10 lbs. to 50 lbs. per acre.

2. The amount of shoot growth, as judged by the weight and number of prunings, was nearly doubled as a result of the injection.

3. The increase was greater in the trees absorbing the larger amounts of fertilizer than in those absorbing smaller amounts.

4. Attack by Apple Leaf Hopper and Red Spider was markedly less severe on the fertilizer injected trees than on the remainder.

5. The quality of the fruit was also affected.

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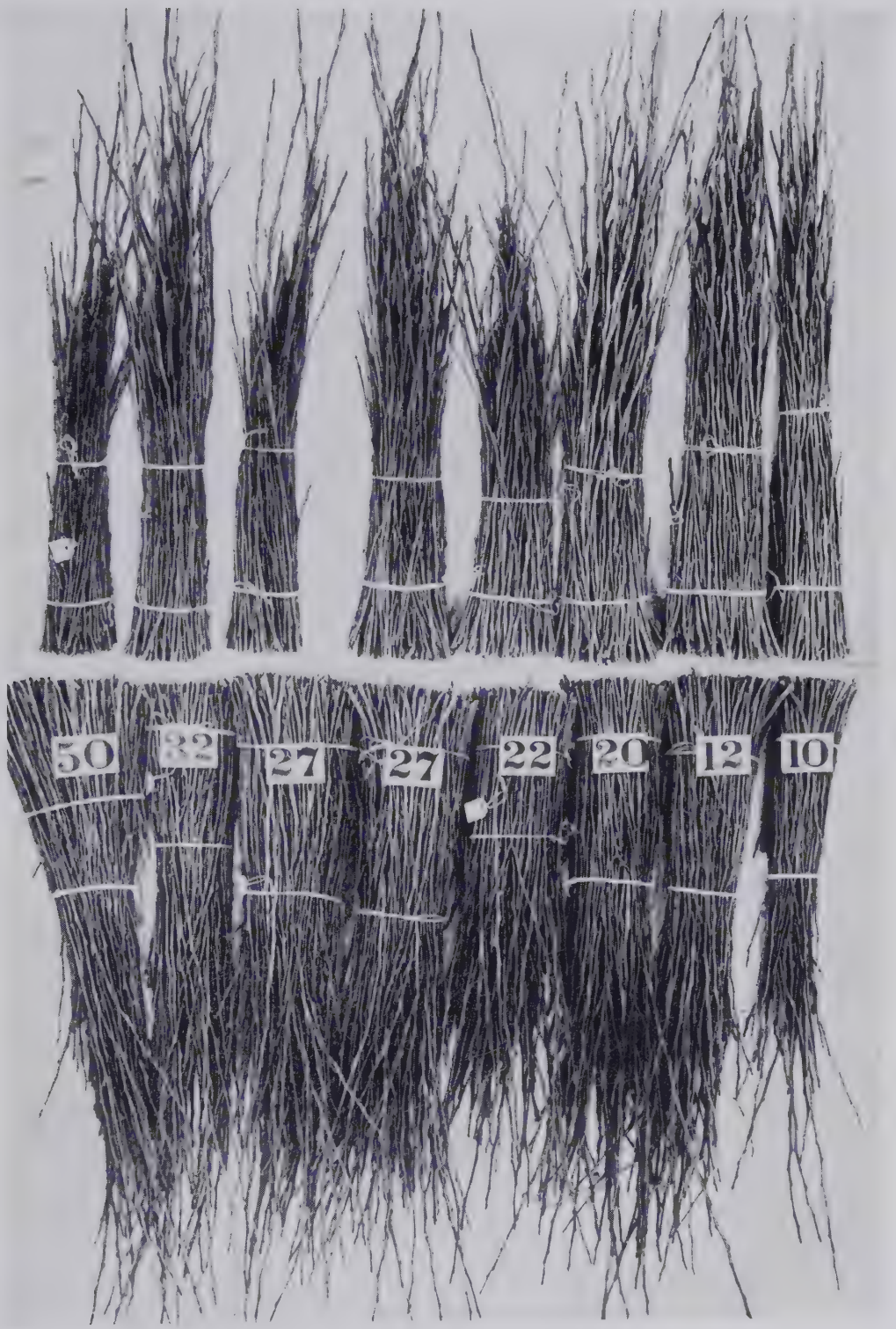
(4) Thomas, L. A. and Roach, W. A. "Injection of Free Trees: Preliminary Experiments with Artificial Manures." Journ. Pom. and Hort. Sci., 1934, **12,** 151-66.



Above : Prunings from uninjected trees.

Below : Prunings from injected trees.

The figures represent the amount of fertilizer injected in lbs. per acre of both potassium phosphate (K_2HPO_4) and urea.

Effect of the injection of 0·1 per cent. ferric chloride on a shoot of a chlorotic peach tree. The two terminal leaves and half of the third have regained their normal colour.

TREE INJECTION—THE DIAGNOSIS AND CURE OF CHLOROSIS IN A PEACH TREE

A PROGRESS REPORT

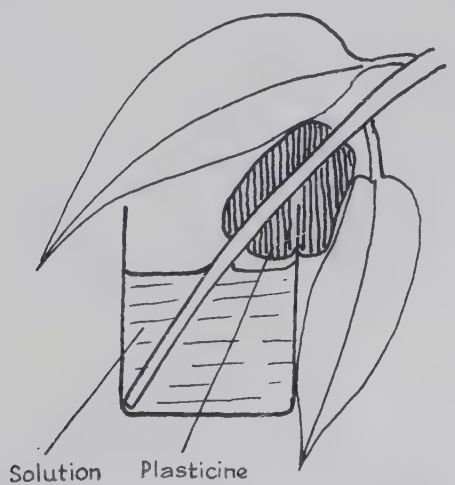
By W. A. ROACH

A LARGE peach tree measuring about 10 ft. by 10 ft. growing in a greenhouse belonging to the Swanley Horticultural College and which had previously borne valuable crops became so chlorotic in 1934 that in May it was difficult to find a single leaf of normal green colour. The tree as a whole was of a striking yellow colour. Extension growth was nearly or quite normal but the fruitlets had remained stationary for some weeks.

The subsoil was chalk, hence the chlorosis was likely to be of the lime-induced class. An excess of lime is known to upset the assimilation of a number of other elements, including iron (2). Although iron appeared the most likely element in the present instance there was no certainty that the other elements were not affected. It was decided, therefore, to test the effect on the tree of solutions containing the various elements, using the twig tip injection method which has already been described (3), before attempting to cure it.

TWIG TIP INJECTION.

Each of a number of current year's shoots was tied with its tip pointing downwards. Enough (i.e. about one inch) of the tip was removed for the cut to be in wood at least partially hardened ; a small glass vessel was fixed with plasticine in the position shown in Fig. 1 and filled with the solution. The tubes were removed after twenty-four hours and the shoots released.



Illustrating method of carrying out twig tip injection.

Diagnosis.

After about a fortnight the shoot which had been injected with 0·1 per cent. ferric chloride bore at its top two and one half leaves of a normal green colour, the remaining leaves on this and on all the other shoots remaining unaffected. A photograph of the shoot is reproduced on Plate facing p. 139.

This experiment proved that suitable treatment with an iron salt, such as ferric chloride, would bring back the normal green colour to the tree.

Cure.

A branch was next injected by a method described elsewhere (3, 4) with the same solution through a hole $\frac{1}{8}$ in. in diameter drilled, with a new metal drill, diametrically through it. As a result of this injection nearly a half of the leaves on the injected branch, and on those nearest it, fell; the remaining ones took on a healthy green colour about a fortnight after the injection. A larger branch making up about half the tree was then injected in a similar manner with a 0·05 per cent. solution of ferric chloride, i.e. half the concentration of the first one. Absorption was allowed to proceed for two days. No leaves fell and no other ill effect was observed; and after about a fortnight all the leaves on the branch had become of a healthy green colour; whereupon the remaining branch was treated in a similar way.

Not only did the foliage of the whole tree recover its healthy green colour, but the fruitlets which had remained of the same size for some weeks, resumed growth. Eventually a crop of nearly normal size and quality was gathered and marketed.

The injection holes had healed so completely by the autumn that it was hard to find them.

Conclusion.

The treatment of lime-induced chlorosis by injection of iron salts was practised many years ago in Germany, following the work of Sachs published in 1886, and injection of solid iron salts has more recently become a commercial operation in America, following the work of Bennett (1). The purpose of the present note is to describe how by using the injection method first on small twigs and later on larger and larger branches, a mineral deficiency may first be diagnosed and later cured in the space of a few weeks without risk of doing serious damage to the tree.

The method has the advantage of being applicable in the summer when the symptoms are actually visible; and it may be so used as to have treated and untreated shoots close together on the same tree for easy comparison. Curative injections may be carried out immediately after the deficiency has been diagnosed or manurial treatment may be applied later. Storey and Leach (5) have used a similar method to diagnose a sulphur deficiency; it seems likely therefore that the method would be useful in other kinds of mineral deficiency.

Acknowledgments.

The writer is grateful to Dr. K. Barratt, the Principal of Swanley Horticultural College, for permission to experiment on the tree, to Miss H. M. Smith and Mr. W. E. Shewell-Cooper for much kindly help; and Mr. J. Amos of this Station for the photograph from which the Plate facing p. 139 was reproduced.

Summary.

1. The cause of a severe chlorosis in a peach tree was diagnosed by small scale twig tip injections.

2. A safe and effective concentration and time of absorption were determined by injecting solutions of iron salts through holes in small branches.

3. The tree was cured by means of injections through holes in the two main branches

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MYCOLOGY AND BACTERIOLOGY

NOTES ON PLANT DISEASES IN 1934

By H. WORMALD

Diseases not Caused by Parasitic Organisms.

Bitter Pit and Lenticel Spotting were both common on stored apples during October, November and December, and many enquiries were received particularly with reference to Lenticel Spotting.* This is so called because a lenticel can generally be seen in the centre of each ; the spots are slightly sunken and dark brown, and usually from $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter. They resemble an early stage of certain fruit rots, and on some apples they were found associated with spots caused by *Gloeosporium album*. Lenticel spotting develops during storage and in many cases apples stored as sound at picking time were severely disfigured in December. The cause of this spotting is not known, but it is believed to have some relation with the weather conditions during the period the fruit is growing. Thus it was very prevalent in 1933 and in 1934, and previously it was severe in 1921, another dry season.

A disease, affecting young trees of Cox's Orange Pippin on No. II stock, causing them to assume an unhealthy appearance and killing some outright, was observed in specimens received from a number of plantations in Essex. The stems and branches of such trees were blistered and bore the fungus *Coniothecium chomatosporum*. The relation between this disease and the associated fungus is not understood, but it is considered that the trouble is mostly of a " physiological " nature, and not the result of primary fungal infection. It is not known why Cox's Orange Pippin on that particular stock should be so susceptible to this disease and an inquiry is being made in order to elicit from the growers concerned what the soil and cultural conditions are in those plantations where the disease is prevalent, in order that the data may be collated in an endeavour to ascertain the underlying factors conducive to the disease.

In May, Conference pear leaves were received each of which showed an interrupted black line on both sides of, and parallel with, the midrib, and $\frac{1}{4}$ to $\frac{1}{2}$ inch away from it. No parasite could be found in the discoloured tissues and the damage appeared to be a form of bruising (probably caused by wind) that occurred while the leaves were still " rolled " before they were fully expanded.

Another result that could only be attributed to wind injury was observed on half-grown apples, the fruit stalk being bent and broken across but not severed. Each affected fruit had a long stalk and the damage was diagnosed as wind damage, for it was considered that the to-and-fro movement of the apple on its long stalk in a gale would be sufficient to bend the stalk so much as to cause it to break. The grower in reply to our letter wrote : " I think there is no doubt your explanation is correct ; it is wind damage as it is only found on long stalks, on Stirling Castle, Allington and Cox's, and only where the stalks are long and slender."

* Further enquiries relating to Lenticel Spotting were received in January and February, 1935.

Several enquiries were received concerning " Shot Hole " in leaves of Rivers' Early Prolific plum. We have never been able to find any parasitic organism associated with this particular type of injury. The spotting on the leaves and the subsequent falling away of the dead tissues to give the Shot Hole appearance bears some superficial resemblance to Bacterial Leaf Spot, but we have not found bacteria in the Rivers' Leaf Spot. It appears rather to be an abnormal " physiological " condition which is probably intensified by dry weather.

Enquiries were received from two localities concerning the small blister-like intumescences which sometimes appear on the under surface of vine leaves under glass. These blisters are not caused by any parasite, but they occur when the atmosphere of the greenhouse is kept too moist, or when there is too great a pressure of sap as would obtain if the soil was too warm and moist.*

In a previous report it was pointed out that spotting of apples may sometimes follow the application of " Bordeaux powder ". Another instance of similar injury came to our notice during 1934 ; in one plantation near Maidstone, Laxton's Superb showed scorching on the leaves and fruit, and Bramley's Seedling on the fruit in June, after being dusted with a " Bordeaux powder ".

Crown-Gall.

This trouble in fruit trees is becoming more prevalent and enquiries have been received from Cambridgeshire, Bedfordshire, Sussex, Herefordshire and Wiltshire concerning Crown-gall on young apple stocks, and with reference to a severe infection on young pear trees near Maidstone. Specimens showing Crown-gall on raspberry (severely galled on the roots and at the collar) and also on rose and dahlia were received.

Apple and Pear Scab (*Venturia inaequalis* and *V. pirina*).

These diseases were less troublesome than usual, the dry weather during spring and summer keeping them in check. A case of severe infection on Conference pears was brought to our notice, however, the owner stating that his Conference crop was " practically wiped out ".

In February and March Bismarck apples from two localities in Kent showed very severe scab infection. The spots were different from the ordinary scab spots in being mostly sunken (saucer shaped) and pitch black. Such infection is known as " Storage Scab " since it develops during the period of storage and may not be noticeable when the fruit is picked. A more detailed account of Apple Scab in storage is given on another page.†

Brown Rot Diseases (*Sclerotinia fructigena* and *S. laxa*).

In spite of the dry summer there was considerable Brown Rot of the fruit (*Sclerotinia fructigena*) in apples and pears as the fruit was ripening. Instances of infection of apples through the wound left at the stalk end, by picking the fruit without stalks, again came to our notice. In March, Brown Rot cankers were found girdling two-year-old apple branches. In April specimens were received from Colchester showing spurs killed by the fruit rot fungus, the grower remarking that : " The spurs of my 6-year-old Cox cordons are going like this and I am in danger of losing all my cordons."

* For further details, see the *Gardeners' Chronicle*, 19th May, 1934, p. 332.

† See p. 232.

The type of injury in these cases was a result of fruit infection in 1933, the fungus extending from the fruit into the spurs. To avoid such damage no rotting fruit should be allowed to remain on the trees ; on cordon trees it should be possible to remove infected fruit before the rot extends into the spurs and in such cases it would amply repay the trouble taken.

The fruit of ornamental almonds is sometimes attacked by *S. fructigena*, and mummied almonds bearing the conidial fructifications of this fungus were received from a garden in Surrey and one in Berkshire. Though in itself this disease on almonds is of little significance, it should be noted that any rotting fruit left on the trees are a potential source of infection for apples, pears, plums and cherries, since all these fruits are attacked by the same fungus.

Blossom Wilt (*S. laxa*) was not generally serious owing to the dry spring, but it was observed on Morello cherries and a few instances of infection through the unopened flowers were again observed on Morellos.

Apple Canker (*Nectria galligena*).

Severe damage caused by the Apple Canker fungus was brought to our notice. Branches of Lord Derby apple trees sent in from Hampshire were badly cankered on the one-year-old twigs and also on the older branches up to one inch in diameter. One Kentish grower brought to us a maiden Crawley Beauty tree with a girdling canker towards the base of the stem ; he said that about eighty trees out of 450 were similarly affected.

In two plantations, on the Tunbridge Wells Sands in the Weald, trees of several varieties, viz. Charles Ross, Rival, Worcester Pearmain and Grenadier, showed a wilting of the leaves on certain branches, sometimes on isolated spurs, and not immediately connected with any lesion. It was found, however, that the wood of the affected branches was discoloured and that the discoloration could be traced downwards to a canker which, in some cases, was several feet from the wilted foliage.

Sooty Blotch (*Gloeodes pomigena*).

This disease which is particularly associated with wet summers was not common during 1934. On apples it was only seen on a few specimens sent in for identification in November, typical blotches being found on apples identified as Bismarck, King Pippin and Wellington. On plums it was again found on the fruit of Warwickshire Drooper, but not on any other varieties, again showing that this variety is particularly susceptible to Sooty Blotch.

Pear Leaf Spot (*Septoria piricola* = *Mycosphaerella sentina*).

Many of the leaves on a pear tree in a Dorset garden showed this Leaf Spot. On some leaves the spots were very numerous (more than 100 on a single leaf) and often confluent. The spots were circular or somewhat irregular in outline, $\frac{1}{16}$ to $\frac{1}{8}$ in. in diameter and pale grey centrally with a dark brown marginal zone. On the upper surface the grey central parts of the spots were mostly studded with black dots, the pycnidia of the Septoria stage of the fungus.

Apple Bud Disease.

In this disease the buds (mostly the flower buds, but vegetative buds also may be involved), after swelling slightly in spring, cease to develop and die. Almost invariably

such buds contain a *Fusarium*, and this fungus appears, therefore, to have some relation to the disease, although there is no experimental proof that it is the primary cause of the trouble. Growers sometimes attribute this disease to tar-oil washing, but it may occur on trees that have not been sprayed with tar-oil ; moreover, it was prevalent in some plantations in Kent before the tar-oils came into general use for winter washing fruit trees. In 1934 specimens showing this disease were received not only from Kent, but also from Northern Ireland and from Birmingham.

Silver Leaf (*Stereum purpureum*).

This disease still continues to be widespread, and in spite of the dry season of 1933 it was seen on a considerable number of plum trees in Kentish plantations during 1934. Often diseased trees are left standing too long in the plantation or they are cut down and left lying about so that the fungus continues to develop on them.

In one plantation a twenty-year-old espalier Peasgood Nonsuch apple tree was killed by Silver Leaf ; the tree died during the summer and specimens of the fungus taken from the trunk were sent to us in October. The tree should have been cut down and destroyed before the fungus developed its fructifications.

In another instance a grower had cut down a row of poplar trees running alongside a fruit plantation ; the cut-off stems were left lying on the ground and in October they bore numerous fructifications of the Silver Leaf fungus.

It cannot be too strongly emphasized that any parts of trees likely to produce the Silver Leaf fungus should not be left in the plantation until autumn, when the fungus develops its fructifications freely and when the trees are particularly susceptible to infection.

Bacterial Canker (*Pseudomonas mors-prunorum*).

This disease continues to be troublesome on plum and cherry trees. In one plantation in North Kent (a young plantation of Victoria plums) many trees died during the summer from cankers on the stem. The Leaf Spot phase of this disease was not serious, being kept in check by the dry weather during the summer, but a little was observed on standard cherry trees and on maiden plum trees on the Station.

Specimens were received from Sussex showing severe infection of the Myrobolan Plum, with cankers on the stems and young twigs, accompanied by Leaf Spot. The organism associated with this disease in Myrobolans has been isolated and is being compared with that causing Bacterial Canker of plum trees.

Witches' Brooms (*Taphrina cerasi*).

Witches' Brooms or " Bull Wood " is a disease of cherry trees which is probably fairly widespread in the south of England as it was seen in various localities in Kent and also in Sussex. A related disease, Cherry Leaf Curl (*Taphrina minor*) was seen on specimens brought in from a fruit farm near Maidstone.

Black Currant Diseases.

Leaf Spot of Black currants (*Gloeosporium ribis* = *Pseudopeziza ribis*) appears to have been less in evidence than in former years as no enquiries were received about it during 1934 ; as this disease is most prevalent in wet seasons the effect of the dry summer was evident.

On the other hand, Black Currant Rust (*Cronartium ribicola*) was unusually prevalent and heavy infections were noted towards the end of the summer. One grower who sent specimens from Lamberhurst wrote: "The leaves are taken from Baldwin bushes, all the leaves of which are covered with the fungus, and immediately adjoining the Baldwins are several rows of Davison's Eight, which do not seem to be affected in the same way at all." It may be necessary to remind growers that the alternate host plants for this rust are the five-leaved pines, *Pinus Strobus* (the Weymouth Pine), *P. Cembra* (the Swiss Stone Pine), and *P. monticola*, and that it is unwise to plant up black currants in the immediate neighbourhood of such pines.

Raspberry Diseases.

Mosaic continues to be the most widespread and troublesome of the diseases affecting raspberry, though the situation is becoming more hopeful since the establishment of mosaic-free nurseries from cane selected and propagated at East Malling.

Cane Blight caused by *Coniothyrium Fuckelii* (= *Leptosphaeria Coniothyrium*) may be very serious at times and two cases came to our notice which illustrate the serious damage that may result from this disease. One farm near Maidstone was visited where it was found that eight acres of Reader's Perfection had just been ploughed up as useless. The canes were seen to be severely infected with the fungus and numerous conidial fructifications were present towards the base of the canes. We were told that practically every stool has been affected and that the average number of healthy canes per stool was only about two. Adjoining was a plantation of Lloyd George raspberries also severely infected; some stools had no living canes at all and most of the stools had one or more dead fruiting canes. A badly diseased stool of Reader's Perfection was brought in to us from another farm in the same locality, and the same fungus again was present; the grower was contemplating ploughing up the field as over half the canes were dead.

Enquiries concerning Spur Blight (*Didymella applanata*) were received from Kent, Sussex and Berkshire.

Strawberry Diseases.

The Yellow-edge disease appears to be widespread as enquiries and specimens have been received from various localities. This is now known to be a virus disease and recent work by Mr. Massee, at this Station, has shown that the Strawberry Aphis (*Capitophorus fragariae*) is a vector of Yellow-edge in Britain.*

Strawberry plants showing the symptoms associated with Root Rot have also been received from various parts of the country. This disease is under investigation at this Station in an endeavour to evaluate the damage caused by root rot and to study means of controlling it.

Other Parasitic Diseases.

Other diseases that came to our notice during the year were, Surface Canker of apple trees (*Myxosporium corticolum*) from Sussex; Dieback of Red currants (*Nectria cinnabarina*); a dying-back of young fig shoots caused by the Grey Mould, *Botrytis cinerea*, the shoots being killed back for about a foot and bearing the Botrytis fructifications towards the lower end of the diseased portion; Gooseberry Cluster Cup (*Puccinia Pringsheimiana*), one enquiry, from Ireland; *Fomes pomaceus* on Victoria and Bush Plum trees near Chatham.

* See *Journ. of Pom. and Hort. Sci.* 1935, **13**, 39-53.

A Non-Parasitic Slime Fungus.

One enquiry was concerning a copious white growth investing clumps of grass in a pasture, the farmer requesting information as to whether this growth was detrimental to stock feeding on the grass. The white masses proved to be the plasmodium of a slime fungus, *Spumaria alba*, which, though it is not a parasite, may be troublesome at times. It is stated that the spores contained in the slime set up irritation of the mucous membrane of animals swallowing it, and the farmer was advised, therefore, to remove and destroy as much of the fungus as possible.

Summary.

Brief notes are given on the plant diseases which came under our notice during 1934. Special attention is directed to :

1. A severe and very prevalent Lenticel Spotting in stored apples.
2. A disease, affecting young trees of Cox's Orange Pippin on No. II. stock, associated with *Coniothecium chomatosporum*, but the primary factors conducive to the disease are obscure.
3. The development of Scab on apple during storage.
4. Bacterial Canker of Myrobolan Plum trees.
5. Severe outbreaks of Cane Blight in raspberries.

BROWN ROT OF PLUMS IN COLD STORAGE

By H. WORMALD and A. C. PAINTER

Since the war the preservation of fruit by storage at low temperatures has developed rapidly, and for dessert and culinary apples (when produced in large quantities as on our Kentish fruit farms) has now become almost a necessity. In recent years the exploitation of cold storage as a means of extending the marketing period of the softer fruit has also come under consideration especially for use in seasons when there is a glut of fruit. One important factor that must be borne in mind however in relation to fruit storage is that temperatures sufficiently low to retard the normal ripening processes of the fruit may not check the development of fruit-rotting organisms to the same degree, and there is much wastage in consequence unless special precautions are taken. This applies particularly to soft fruits, which are more readily attacked than apples by rot-producing fungi.

The installation of cold storage chambers on this Station enabled us to make observations, during the past season, on rotting in plums stored at a temperature round about 40° F.

About the middle of October, three to four weeks after the fruit was put into cold storage, it was noticed that many were rotting and becoming covered with a conspicuous white fluffy fungal mycelium. On many of these the white mycelium was tinged greyish or yellowish and on some of them definite Monilia pustules (though not so compact as those found on fruit in the open) were present, suggesting that the rot was largely due to the Brown Rot fungi.

In Britain the two Brown Rot fungi, *Sclerotinia fructigena* and *S. laxa** are both responsible for considerable wastage of plums as they are ripening on the trees ; in most seasons *S. fructigena* causes more fruit rot than *S. laxa*, even in the stone-fruits, although it is the fungus which is so commonly associated with rotting in apples and pears, and, in the past has been considered to be almost confined to the core-fruits.

Experience has shown that Brown Rot is an important factor in the cold storage of plums and this phase of the disease would appear to demand further attention.

Samples of the rotting fruit were taken into the laboratory and examined more closely in order to determine which fungi were chiefly responsible for the wastage. Twenty German Prunes were taken at random ; of these, four showed the greyish conidial fructifications of *Sclerotinia laxa*, eleven the yellowish fructifications of *S. fructigena* ; two bore *S. fructigena* and *Botrytis cinerea* (the latter in a patch at one end and probably secondary, following *S. fructigena*), one a *Penicillium*, and two showed what appeared to be white mycelium only, but microscopic examination revealed the presence of a few chains of conidia of *S. fructigena*. Thus *S. fructigena* was found on fifteen out of twenty infected plums.

Twenty specimens of rotting Cluster Damsons were next examined, with these results :

Eight bore fructifications of *S. fructigena* together with the white mycelium.
One bore *S. laxa*.

* *Sclerotinia laxa* is the Brown Rot fungus (with *grey* Monilia fructifications) that in the past has been generally known as *Sclerotinia* (*Monilia*) *cinerea*. The reason for the change in nomenclature will be found on pp. 6 and 7 of a Bulletin recently published by the Ministry of Agriculture (4).

Two a *Penicillium* sp.

Nine had mostly white mycelium but a few scattered chains of *Monilia* conidia were present. The size and shape of these conidia corresponded to those of *S. fructigena.*

Here again *S. fructigena* was the fungus most frequently found, being present on seventeen out of twenty fruits.

Many of these smaller plums had been picked without stalks and it appeared probable that the fungus had gained entrance, in many cases, through the wound left at the stalk end, a mode of infection that has been found in apples (2, 3).

To obtain confirmation of the presence of *S. fructigena* within the tissues of the fruit, two German Prunes and two Cluster Damsons, with white mycelium but no definite fungal fructifications, were taken; portions of the surface free from mycelium was cleansed by sponging with cotton wool moistened with alcohol to remove any spores that might be present on the surface, and with a sterile scalpel particles of the internal tissues were removed and transferred to prune agar plates. In six days the growth on the plates was as follows:

German Prune No. 1.	*S. fructigena* only.
German Prune No. 2.	A species of *Mucor* only.
Cluster Damson No. 1.	*S. fructigena* and *Mucor* sp.
Cluster Damson No. 2.	*Mucor* only.

Other plates were prepared likewise and these gave similar results: sometimes *S. fructigena* grew out pure, sometimes a mixture of *S. fructigena* and *Mucor*, and on some *Mucor* only appeared.

Species of *Mucor* are sometimes found on over-ripe fruit, but they are not nearly so destructive to tree fruits as the Brown Rot fungi. In the present case *Mucor* probably attacked the fruit in the later stages of storage.

On 25th October more plums were brought in from the cold store—samples of Quetsche and White Bullace. The Quetsche plums showed white mycelium only; no conidial fructifications could be found on them. Nine of these were united in one bunch, and several smaller clusters of adhering fruit were found, suggesting that in each case the rot had started in one plum and then extended from this primarily infected fruit to those around it. This transmission of rot from one fruit to those in contact with it and the close adhesion of all in the bunch to form a more or less compact mass commonly occurs on fruit infected with Brown Rot while on the tree.

The White Bullace appeared to have been more recently infected, many of them showing rot round the stalk end only, with no fungal fructifications.

Another method of identifying the fungus present on the fruit was adopted in this instance. *Sclerotinia fructigena* requires light to induce it to develop its fructifications; the specimens were therefore placed in front of a window so as to be fully exposed to daylight. All the Quetsche developed definite yellowish pustules of the Monilia stage of *S. fructigena* within nine days. On the other hand less than half of the White Bullaces exposed to light developed *Monilia fructigena*; on those noted as having stalk-end rot the actual decay proceeded very slowly and eventually *Botrytis cinerea* appeared, so this form of decay was probably due to over-ripeness and not caused primarily by a parasitic fungus though hastened by it.

No rot was seen on President plums at this time, but this is a large fruit that can be picked without risk of much injury. If this variety is picked with stalks and stored carefully in shallow layers, so as to avoid injury as much as possible, it should keep well in cold storage. It would appear that such varieties as Cluster Damson, Quetsche and Bullace might profitably be stored if they are picked and handled with due care to avoid unnecessary injury.

Control Measures.

In order to avoid as much as possible this wastage from Brown Rot of plums in cold storage, attention should be given, in the first place, to orchard sanitation so as to keep the Brown Rot fungi in check while the fruit is still on the trees ; mummied and rotting fruit should be destroyed by burning whenever possible. Plums intended for storage should be picked with extra care so as to avoid injury, and with their stalks. Any fruit showing a trace of rot should be rigorously excluded. It would be inadvisable to store plums taken from a tree showing much Brown Rot for in all probability many of them, though apparently sound on a casual examination, would already be infected and would not only rot in storage but would transmit the rot to those in contact with them. If possible the plums should be stored in shallow layers and examined from time to time so that any showing symptoms of rotting could be promptly removed.

In this connection attention is called to the work carried out by Kidd and West (1), who recommended for the cold storage of plums the following additional precautions. (1) Wet fruit should not be stored. If fruit is wet and has to be stored, it should be allowed to dry as quickly as possible. (2) Condensation of moisture on the surface of the fruit on removal from store should be avoided as far as possible as such moisture generally promotes serious and rapid fungal rotting.

Acknowledgment.

The writers are indebted to Dr. Cyril West of the Ditton Laboratories for advice during the preparation of this article.

Summary.

Plums rotting in cold storage at about 40° F. bore white fluffy mycelium associated with relatively few fungal fructifications. An examination was made to determine the fungus or fungi chiefly responsible for the rotting. The fungi observed were *Sclerotinia fructigena*, *S. laxa*, *Botrytis cinerea*, *Penicillium* sp. and *Mucor* sp. Of these the predominating fungus was *S. fructigena*. The white mycelium with which the fruit becomes invested is a result of darkness under storage conditions ; when the plums were exposed to light the fungus showed a tendency to develop its normal yellowish cushion-like Monilia fructifications. Infected plums were often found adhering in clusters showing that under storage conditions (as on the tree) infection may extend from one primarily infected fruit to those in contact with it. Recommendation for reducing this wastage caused by Brown Rot in storage are sanitary measures in the plantation, together with careful picking and storing so as to avoid injuring the fruit.

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PRELIMINARY LABORATORY TESTS OF BACTERICIDES ON THE PLUM BACTERIAL CANKER ORGANISM

By H. WORMALD

Introduction.

Measures for controlling Bacterial Canker in plum and cherry trees cannot at present be recommended with confidence because of the lack of experimental evidence as to the efficacy of certain treatments that are suggested by a study of the habits of the causal organism.

Possible control measures are sought along two main lines, (1) the application of bactericides with the object of preventing the organism from entering the tree, (2) modification of existing orchard practices so as to render the trees less susceptible to infection by (a) avoiding injuring the trees at times when they are most liable to become infected, (b) by building up resistant stems, and frameworks of stem and branches to support a more susceptible scion.

With regard to bactericides there are three ways in which it is conceivable that they may be of use, (1) for painting over wounds when it is found necessary to prune, de-feather, or cut out branches, (2) for protection against the Leaf Spot phase by spraying the foliage in spring and summer, (3) for protection against the all-important canker phase by spraying the trees with a bactericide to prevent stem and branch infection in the autumn.

In America where Fire-blight, caused by *Bacillus amylovorus*, is a serious menace to pear and other fruit trees, the cutting out of diseased parts and covering the wounds with a bactericide is now routine practice. In Britain, in the case of bacterial cankers caused by *Pseudomonas mors-prunorum*, the situation is rather different for the infection of young shoots is rare and the extension of lesions from such shoots into the older parts in summer has not been observed. Moreover " hold-over " cankers, necessitating cutting out and painting, are not known to occur in plum and cherry Bacterial Canker. Injuries made in autumn, however, are liable to allow of infection and any pruning wounds made during late summer and in autumn should receive a protective covering.

Leaf spots caused by bacteria have in certain cases yielded to spray treatment ; thus some measure of success has attended the use of Bordeaux mixture against Walnut Blight (*Pseudomonas Juglandis*) and zinc-lime against Peach Leaf Spot caused by *Bacterium Pruni*. It seems possible, therefore, that Bacterial Leaf Spot on plum and cherry trees, the phase in which the Bacterial Canker organism passes the summer, will yield to similar treatment.

The most serious phase of bacteriosis in plum and cherry trees is Bacterial Canker. Field observations and inoculation experiments have shown that infection of stems and branches occurs in autumn. It is concluded, therefore, that the application of a bactericide in early autumn should offer protection from such infection, and experiments are under way to test whether such applications are efficacious.

In the meantime, various bactericides are being tested under laboratory conditions to ascertain their inhibitory and lethal effect on *Pseudomonas mors-prunum*, with the object of incorporating the most promising into preparations that can be applied to the trees, either as sprays, for foliage, branches and stems, or as " paints " for protecting wounds.

The effect of toxic substances on bacteria may be tested in either of two ways, (1) in preventing growth—bacteriostatic or antiseptic action, (2) bactericidal, when the organism is killed. Bacteriostatic tests are commonly employed in laboratory experiments, and often, particularly in medical and veterinary work, the results give a useful clue as to the concentrations that can be safely used to prevent infection. In such tests, if the organism is merely prevented from development and not killed, it may resume growth when the effect of the antiseptic disappears ; this applies more particularly to volatile substances. In some cases, therefore, it is necessary to know at what concentrations, and in what time, a substance kills the organism, and bactericidal tests must be applied.

In the plant disease under consideration it is necessary to obtain data on both points, for in applying a spray fluid to foliage, a low concentration is sought that is antiseptic and yet not harmful to the leaves, while if the spray is to be applied to stems and branches at the end of the growing season, a stronger concentration as a bactericide can be employed.

Two strains of *Ps. mors-prunorum* were used in the earlier tests ; one of these proved to be more sensitive to toxic substances than the other as its growth was checked or prevented altogether at concentrations lower than those necessary to produce a similar reaction on the more resistant strain. The latter was therefore used in the later tests since any concentration toxic to this strain would also be toxic to the more sensitive strain.

Bacteriostatic Tests.

In bacteriostatic tests the object is to ascertain the lowest concentration of the toxic substance that will prevent bacterial growth. The results obtained give no indication, therefore, how soon the bacterium is killed nor do they show that the substance actually does kill the organism. In some tests, growth was inhibited for over a week yet the organism eventually began to develop and produced good growth.

The organism was inoculated into tubes of a culture medium containing the toxic substances at various concentrations, and the resultant growth, if any, was compared with control inoculated tubes. Nutrient broth containing 1 per cent. saccharose was the culture medium used in these tests, and 9 c.c. were run into each of a series of test-tubes and the tubes sterilized.

Stock solutions of the various antiseptics were prepared at relatively high concentrations so that they were considered to be quite sterile ; with suitable dilutions, using sterile water and sterile pipettes, concentrations at ten times those of the final culture tubes were prepared and 1 c.c. of one of these together with the 9 c.c. of nutrient broth – saccharose produced a culture tube containing the desired concentration of the antiseptic.

Control tubes were set up in which 1 c.c. of sterile water only was added to the 9 c.c. of culture medium. Some of these were inoculated for comparison with inoculated tubes containing the toxic substances so that any check to growth in the latter could be noted. Others were left uninoculated ; these have always remained sterile showing that the risk of contamination during the operation of diluting is slight.

Phenol was included in these tests as it is a disinfectant commonly used as a standard with which to compare other toxic substances. At a concentration of 0·05 per cent. growth was checked but very slightly and 0·1 per cent. was necessary to prevent growth altogether.

Alcohol. The stock used for dilution was absolute (ethyl) alcohol. With 1 per cent. there was little, if any, check to growth. 5 per cent. prevented growth for some days and with 8 per cent. a very slight clouding was noticed after about three weeks, but this did not increase in intensity and sub-inoculations gave no growth.

Formaldehyde. This is generally recognized as a strong bactericide and the present tests show that it is very toxic to *Ps. mors-prunorum.* It is doubtful, however, whether it can be used with advantage in the control of Bacterial Canker because of its ready volatility and the irritating fumes which are emitted.

0·002 per cent. produced very slight check.
0·005 per cent. produced a definite check at first but growth eventually was equal to that in control tubes.
0·01 per cent. no growth.

The gas formaldehyde in solution at 0·01 per cent. is the equivalent of one part of commercial formalin (40 per cent.) in 4,000 parts of water.

Chinosol (8-hydroxy-quinoline potassium sulphate), is a strong disinfectant used in hospitals and in veterinary work. 0·001 per cent. checked growth at first and the tubes did not show such vigorous growth as control tubes even after a fortnight. There was no growth with 0·005 per cent.

Copper Sulphate. As copper sulphate is the active constituent of Bordeaux Mixture it was included in these tests. The results, however, were irregular and do not represent the true bacteriostatic effect. Copper sulphate reacts with certain constituents of nutrient broth to form a precipitate which not only reduces the nutritional value of the culture medium but removes some of the copper sulphate from solution.

In these tests 0·01 per cent. checked growth at first and no clouding due to growth was observed for three days. 0·1 per cent. prevented growth for about a week but eventually there was good growth ; 0·2 per cent. prevented growth altogether.

These concentrations are very high compared with those for similar tests with zinc sulphate and those obtained in the bactericidal tests described later. Preliminary tests with another culture medium, in which copper sulphate reacts but slightly with the constituents, have shown that growth is inhibited by concentrations of copper sulphate far lower than those here shown.

Copper chloride was rather more effective in these tests than copper sulphate. 0·005 per cent. checked growth for a few days and 0·01 per cent. prevented growth.

Copper ammonium sulphate and *copper ammonium chloride* behaved much like copper sulphate, 0·1 per cent. preventing growth for about a week, but later good growth was shown.

Zinc sulphate was included in these tests as it is the active constituent of the so-called zinc-lime spray which has recently been recommended in America for use against Peach Bacterial Leaf Spot, as being less harmful to the foliage than Bordeaux Mixture. With regard to its use against bacteriosis of stone-fruit trees in this country, it was thought that this spray might be employed against the Leaf Spot phase on certain

varieties of plum and cherry which have proved liable to be injured when the foliage is sprayed with Bordeaux Mixture, so some information on the toxicity of zinc sulphate towards *Ps. mors-prunorum* was desirable.

In these bacteriostatic tests, using nutrient broth + saccharose, zinc sulphate was more toxic than copper sulphate. Thus 0·002 per cent. checked growth and 0·005 per cent. prevented growth completely. Its apparent superiority over copper sulphate is due to the fact that it does not produce any marked precipitate when introduced into the culture medium.

In the bactericidal tests, as shown below, copper sulphate was definitely more toxic than zinc sulphate.

Mercuric chloride. Of the mercury compounds mercuric chloride has long been known to be a powerful germicide. Because of its very poisonous properties it is not often employed in plant protection measures though some of the organic mercurial compounds are commonly recommended as seed-dressings, and one of them has been recommended for use against crown-gall on nursery trees. Mercuric chloride is one of the ingredients of a preparation used in the United States and in Canada for dressing cankers and pruning-wounds as a protection against Fire-blight (*Bacillus amylovorus*) and it is possible, therefore, that it may be found of use as a protective when plum and cherry trees have to be cut back at a time when they are liable to become infected.

Mercuric chloride proved to be very toxic to *Pseudomonas mors-prunorum*. At 0·0001 per cent. (one part in a million) it prevented growth for about a week in some tests; growth usually appeared after this, but in one test there was no growth to the end of the experiment (five weeks). 0·0005 per cent. prevents growth altogether.

Preliminary tests have been made with two organic mercurial compounds. One of them proved to be more toxic, the other definitely less toxic than mercuric chloride against *Ps. mors-prunorum*. These organic mercurials are being further tested.

Bactericidal Tests.

The object in these tests is to determine what concentrations of the toxic substances actually kill the organism and the time taken to kill. Special attention was given to copper sulphate and zinc sulphate, as being the active components of Bordeaux Mixture and zinc-lime respectively, sprays that have been used with some success against certain bacterial diseases of plants.

A commercial brand of tar-oil was also included in these bactericidal tests as the use of tar-oil for winter-washing trees is now common practice in fruit plantations. The tar-oils are unsuitable for bacteriostatic tests because of the cloudy emulsion which masks any visible evidence of growth.

The bacterial slime from a vigorously growing culture on nutrient agar (+ 5 per cent saccharose) was transferred to a tube of sterile water to form a cloudy suspension, and this was used for inoculating the tubes containing the solutions to be tested.

Copper sulphate and *zinc sulphate.* Solutions of copper sulphate and of zinc sulphate at concentrations of 0·2, 0·1 and 0·01 per cent. were prepared in test tubes. These were inoculated from the cloudy suspension of the organism and from them, sub-inoculations to tubes of a normal culture medium were made at intervals of 10 minutes, 1 hour, 3 hours and 20 hours.

The inoculations from the tubes containing copper sulphate gave no growth whatever so that copper sulphate at 0·01 per cent. killed the organism within 10 minutes; lower concentrations have not yet been tried.

The inoculations from the tubes containing zinc sulphate, however, gave rise to growth in all the culture tubes except those inoculated at the end of 20 hours; in these the tubes inoculated from 0·2 and 0·1 per cent. remained clear and those from 0·01 per cent. showed a very faint turbidity which remained faint even after a fortnight. It follows, that as a bactericide, copper sulphate acts far more rapidly than zinc sulphate.

Tar-oil. It was found that at 1 per cent. the tar-oil killed within ten minutes, though at 0·1 per cent. it did not kill in an hour. It would seem that tar-oils might help to keep the bacterial canker organism in check in fruit plantations, for it is used at strengths ranging from 5 to 10 per cent. It is usually applied, however, at a time later than that at which stem infection, resulting in cankers, is believed to take place.

Summary.

Preliminary tests with certain germicides have been undertaken to ascertain their bacteriostatic and bactericidal effect on *Pseudomonas mors-prunorum*, the cause of Bacterial Canker of plum and cherry trees in Britain, with the object of choosing substances that may eventually be used in controlling the disease. The organism is found to be very sensitive to low concentrations of certain well-known germicides.

SOME OBSERVATIONS ON THE RASPBERRY DISEASE SITUATION IN NORTH AMERICA

By R. V. HARRIS

I. Introduction.

Late in May, 1933, the writer sailed for Canada for a year's residence at the Dominion Laboratory of Plant Pathology at St. Catharines, Ontario, in exchange with Dr. G. H. Berkeley, Senior Pathologist, in charge of that laboratory, who was stationed during this period at East Malling. For a number of years previously the writer had been making a special study of the diseases of raspberries and more latterly had specialized on the virus diseases of this crop and of strawberries. The principal objective of the exchange year from his point of view was the enlargement of his field of observation and experimentation on the latter group of diseases, and he could not have been stationed at a better centre for such a study. St. Catharines is situated on the shores of Lake Ontario in the heart of the fruit belt of the Niagara Peninsula, one of the most intensive fruitgrowing sections in Eastern Canada, and the staff of the St. Catharine's laboratory is engaged in research in diseases of the economic crops grown in this section and the diseases of small fruits figure prominently in its programme. The laboratory is also the centre for the administration of the Dominion Government Certification Scheme for raspberries in Ontario and, for the purely Horticultural and Entomological aspects of small-fruit growing, is within easy reach of the Provincial Horticultural Experiment Station and the Dominion Entomological Laboratory at Vineland. The University of Toronto, where considerable research is in progress on fruit diseases, is only eighty miles distant, the Ontario Agricultural College at Guelph sixty miles, and the Administrative Headquarters of the Division of Botany of the Experimental Farms Branch of the Federal Department of Agriculture at the Central Experimental Farm, Ottawa, can be reached in two days by road. Further, St. Catharines is only a few miles from the port of entry to the United States at Niagara Falls, and the New York State Agricultural Experiment Station at Geneva, an important centre for raspberry research, could be reached by road in half a day.

Although the greater part of the year was spent at the St. Catharines laboratory in experimental work, in visits to the institutions mentioned and in accompanying members of staff of the laboratory on tours of inspection in the Province, tours were also made by road to the small-fruit growing section in the neighbourhood of Montreal, throughout the North-Eastern States of America down to Washington, D.C., and to the strawberry growing section in Louisiana. At the conclusion of the year's residence, a three months' extension of leave of absence from East Malling was obtained in order still further to extend the field of observation to the Canadian Middle West and to the fruit sections of British Columbia, at the suggestion and by the generous invitation of the Federal Department of Agriculture.

Pending the completion of detailed reports covering all phases of the exchange period, the present essay summarizes the raspberry disease situation as observed and studied at St. Catharines and district, and during the above-mentioned travels from this centre, with special reference to the virus diseases of this crop.

II. Eastern Canada and United States.

One's first impression of the raspberry disease situation in Eastern Canada and United States was its resemblance in general feature to that in England. Various fungus diseases such as *Verticillium Wilt* (similar to our *Blue Stripe Wilt*), *Cane Blight* and *Spur Blight* take their toll of canes. Economic attacks of Spur Blight are of more frequent occurrence than in England and a very effective routine control measure (by the use of Bordeaux mixture) has been formulated at the St. Catharines laboratory. Cane-spot (*Elsinöe veneta*) or Anthracnose as it is known in America is not considered economic on the red-raspberry but is of serious import in districts where the black-raspberry is grown. Canes of certain varieties such as the well-known *Viking* variety (recently introduced by the Vineland Experiment Station) commonly showed scattered pit-lesions of this disease, and it seemed possible that an attack of even such low intensity might possibly increase the susceptibility of the cane to winter injury, that all-important factor in Eastern Canada. But, as in England, virus disease dominates the disease picture throughout Eastern Canada and U.S.A.

It was abundantly clear, both from data gathered from the experts with which the writer was associated and by personal observation that on the Niagara Peninsula and in the other raspberry growing sections of *Eastern* Canada and United States, that as in Great Britain virus disease is a limiting factor of major and critical importance to the cultivation of some of the leading varieties of red-raspberry such as Cuthbert, Viking, etc. The first striking feature noticed was the occurrence of certain virus diseases not yet recorded in Britain, among which may be mentioned the *Leaf-curl* disease of black and red varieties. Red-raspberry stools infected with this disease were found to succumb much more rapidly than stools infected with mosaic disease which under most conditions acts relatively slowly, as in Great Britain. The spread of leaf-curl infection from stool to stool is, however, much slower than that of mosaic.* This and the ready identification of diseased stools makes the control of leaf-curl on red-raspberries a relatively simple matter. Transfers of a leaf-curl virus were made, at the St. Catharines laboratory, from the native *Cuthbert* variety to virus free plants of the English varieties *Lloyd George* and *Baumforth's Seedling B.* by means of the patch-grafting method devised for such purposes at East Malling. The action of the disease on these varieties was extremely drastic, the infected plants succumbing within a very short time of showing leaf symptoms as observed on the American varieties. These experiments thus provided additional evidence of the non-occurrence or extreme rarity of leaf-curl on leading commercial varieties in England. Cases of leaf-curl were commonly observed throughout Eastern Canada and the United States and also in the Canadian Middle West (the Prairie Section), but were not observed in British Columbia.

American workers have distinguished two forms of mosaic disease on both red and black varieties, (1) *Red-raspberry mosaic*, and (2) *Yellow-mosaic*, the former being the most prevalent and important on red-raspberries in the North East sections. The great majority of black-raspberry varieties are highly susceptible to Red-raspberry mosaic and all are equally highly susceptible to Yellow-mosaic. Stools cease cropping and usually succumb completely during the season after infection. Unfortunately, unlike leaf-curl, this high susceptibility is, on the majority of varieties, accompanied by a very high rate of spread of infection (high infectibility), so much so that the spread of infection cannot adequately be checked simply by "roguing" diseased stools, but it is also

* American workers have shown that the vectors of mosaic and of leaf-curl are distinct species of aphides and that the movement of the leaf-curl vector is much more restricted than that of the mosaic vector.

necessary that the plantation should be far removed from plantations of red-raspberries or any other possible source of infection. Valuable breeding work on black-raspberries at Geneva, New York and other centres has recently yielded new seedling varieties which show great promise of a low infectibility to the mosaics.

On black-raspberries the two American forms of mosaic can easily be distinguished in the field. On red varieties such diagnosis is not nearly so easy, e.g. the two sets of symptoms are not so readily distinguished as the recently described types of mosaic on the variety *Baumforth's Seedling B* in England. Instruction on field reading of symptoms of Red-raspberry mosaic and Yellow-mosaic was received from one of the leading authorities on these diseases in America, Dr. H. W. Rankin of the New York Agricultural Experiment Station at Geneva, but even so the writer found it very difficult confidently to distinguish stools infected with one or the other forms of mosaic, and the need for confirmatory methods of diagnosis was very apparent. This led to preliminary experiments at St. Catharines in the separation of the two mosaics by the aforementioned patch grafting method of transmission, which gave promising results and are being continued at the St. Catharines laboratory under a collaborative arrangement.

It remained to determine experimentally whether, as then seemed extremely likely, these American raspberry mosaic diseases and the analogous diseases in Great Britain were identical. To this end virus-free plants of the English varieties *Lloyd George* and *Baumforth's Seedling B*, shipped from East Malling, were infected (under glasshouse conditions at St. Catharines) by the grafting method, with virus from canes of local varieties such as *Cuthbert* and *Viking* showing typical symptoms of the prevalent mosaic.* Unexpectedly the two English varieties reacted to the American virus in a manner quite distinct from their reaction to the English mosaics in the parallel experiments carried out at East Malling, indicating that an assumption of the identity of at least *one* of the American mosaics with those in Great Britain would (to say the least) be premature pending confirmation of the implications of these results by further experiments which will be carried out at St. Catharines and at East Malling, under a collaborative arrangement.

III. Lloyd George Raspberry in North America.

The advisability for a final determination of the relation between the mosaics in North America and Great Britain, in view of the reciprocal interchange of cane which takes place between England and America, became very evident during one's travels, particularly from observations made on the behaviour in North America of the well-known English variety *Lloyd George* which in recent years has been imported and widely planted up for trial in the raspberry growing sections throughout Canada and the United States.

It soon became evident that in Eastern Canada and U.S.A. the Lloyd George raspberry does not grow or crop satisfactorily in the great majority of localities in which raspberries are grown commercially. That this failure is not, however, primarily due to mosaic infection was indicated by the experience of workers in Canada and the States and by personal observation, from which it would seem that the appearance of mosaic symptoms on this variety is of extremely rare occurrence. Thus during the writer's travels in Southern Ontario and in the Eastern United States many plantations and nursery beds of Lloyd George were examined but no stool showing the unmistakable mosaic symptoms, which are so frequently met on this variety in England, was seen.

* When these transmissions were made the writer was not able to distinguish with certainty the symptoms of the two American forms of mosaic. Canes were selected showing mosaic symptoms typical of that generally observed. In future experiments it is hoped to carry out transmissions with each form of mosaic, separately and in combination.

At the Geneva Station Dr. Rankin informed the writer that the Station's original stock of Lloyd George was imported some years ago from a nurseryman in the South of England and on first planting out, a number of stools showing mosaic had to be eliminated, but after that mosaic stools were only rarely found, in spite of the propinquity of infected native varieties. This apparent very low infectibility of Lloyd George under Eastern American conditions contrasted strikingly with the behaviour of native varieties planted adjacently to it, for mosaic infected canes were regularly and frequently being removed from rows of these varieties but only rarely from the Lloyd George rows. The possibility that the symptoms of mosaic were masked under these conditions was considered but against this is the fact that when Lloyd George stools were artificially infected with mosaic from local varieties by grafting (in the experiments described below) clearly marked symptoms rapidly became evident, indicating a high susceptibility to these mosaics. This rare appearance of symptoms on Lloyd George in Eastern America is therefore indicative of a very low degree of infectibility of this variety to the American Mosaics, and of a possible distinction between these mosaics and those to which Lloyd George is subject in England. These conclusions were further confirmed in British Columbia.

The fruit district of the Okanagan Valley, B.C., is not, generally speaking, a raspberry growing district, owing to its very dry climate. At the Dominion Experimental Farm at Summerland, however, propagating beds had been established for supplying reliable cane to growers in other parts of the Province. The insect fauna of this locality is very prolific and the conditions are outstandingly favourable for the very rapid spread of virus diseases in general and of raspberry mosaics in particular. The raspberry plantation at Summerland consists of rows of native varieties such as *Cuthbert*, *Viking*, *Latham*, etc., and adjacent to the row of *Viking* a row of *Lloyd George* from carefully selected cane was established at the same time. Mr. R. C. Palmer, Superintendent of the farm, informed the writer that, from the time of planting, fresh cases of mosaic were frequently identified and removed from rows of *Viking* and other of the native varieties but that no cases had appeared to date in the adjacent *Lloyd George* row. In the neighbourhood of Victoria, B.C., several newly planted plantations of Lloyd George were also found to contain a high percentage of stools with distinct mosaic symptoms indistinguishable from typical mosaic stools of this variety in England, but in each such case it was found that the cane was freshly imported from the ordinary commercial sources in England, and it consequently followed that the mosaic stools had most probably been infected before leaving England. Other plantations in the same neighbourhood planted from cane in the first place carefully selected and imported from England personally by a grower on settling in Canada some ten years ago, were found to be virtually free from mosaic infection. Further, in 1932, on the suggestion of Mr. R. C. Palmer, then in residence at East Malling, 500 virus-free Lloyd George canes from the East Malling cane nurseries were sent out to a prominent nurseryman in the Fraser Valley. The cane progeny (by vegetative division) of this batch of cane, now numbering many thousands, was examined by the writer during his tour and no trace of mosaic infection could be found. The above observations indicate that in the Canadian West as in the East the spread of the form of mosaic native to this variety and introduced in it from England is extremely slow, or does not take place, and that its infectibility by the mosaics occurring on the native varieties is also very low, or non-existent.

If, however, as would seem, the virus disease situation in Lloyd George in the Canadian West is strikingly similar to that in the Eastern Provinces, the actual performance of the variety is very different, for in recent years extensive cropping trials in British Columbia and in Washington and Oregon have given very promising results

which have led to its recent wide recommendation and planting up, together with such varieties as *Chief* and *Viking* as an alternative to the hitherto omnipresent *Cuthbert* berry (see below). It may be concluded, however, that it is unlikely that mosaic disease is a major contributing factor to such contrasted behaviour, which on the contrary is clearly mainly due to a deficient adaptability of the variety to the conditions of growth in the majority of the Eastern Sections. It would also follow that the control of mosaic in this variety in North America is a simple matter and consists mainly in the elimination before, or immediately after importation, of the cases of mosaic infection originating in Great Britain.

IV. The Canadian West.

The above brings us naturally to a general consideration of the raspberry disease situation in the North West. The only two fungus diseases of serious economic importance are (1) a disease formerly described under the name of " Anther and Stigma Blight " and latterly more generally referred to as the " Dry-berry disease ", and shown to be caused by the fungus *Hapalosphaeria deformans*, and (2) Cane-blight (*Leptosphaeria Coniothyrium*). The former disease is of particular interest as it has not yet been recorded in Eastern Canada or in Great Britain. The loganberry is particularly susceptible to attack in certain sections on Vancouver Island where this crop is extensively grown for winemaking, and where the injury caused to the berries can only be compared in extent and seriousness to that caused by the raspberry and loganberry beetle in England. Interestingly enough the leading red-raspberry grown in this district, namely Cuthbert, has been found to be very resistant to the disease but, on the other hand, the Lloyd George berry is extremely susceptible. Direct control presents a problem of great complexity because of the widespread infection of a native wild species of Rubus—the Thimbleberry (*R. parviflorus*) which is always found growing in the woods bordering the plantations. The Assistant Plant Pathologist to the Provincial Department of Agriculture, B.C., is making an exhaustive study of this important disease from all points of view.

The virus disease situation can best be visualized by following the fortunes of the important *Cuthbert* variety throughout the various fruit sections visited in Eastern and Western Canada and U.S.A. This variety is still the most widely grown in Canada and according to many authorities has never been surpassed for berry quality (for dessert, jam and canning). In North America it has a much greater effective locality range than the *Lloyd George* as it is a leading variety in Ontario and until recently practically the sole variety grown on Vancouver Island and in the Lower Fraser Valley. From Ottawa eastwards to Quebec and the Maritime Provinces, however, its degree of winter hardiness is inadequate to ensure its wide cultivation. On the Niagara Peninsula and in the other fruit districts in Southern Ontario its continued cultivation was secured as a result of an improvement of the existing sources of cane supply by the gradual elimination of mosaic infection under the Dominion Government Cane Certification Scheme to be described later (see p. 161). Then in the west within the last fifty years the important raspberry growing industry of the Lower Fraser Valley was built up entirely with the *Cuthbert* variety which was found to yield magnificent crops on the rich alluvial soil made available by the clearing of the native bush. Recently, however, a critical situation had arisen in this district owing to a widespread deterioration of these Cuthbert plantings, and thence arose the suspicion that the vigour of this original stock of Cuthbert cane was becoming exhausted, which led to recent importations of fresh stocks of *Cuthbert* from Ontario and the importation and trying out of other varieties such as *Viking*, *Chief*

and *Lloyd George*. As a rule, however, it was found that the performance of this fresh imported cane was no better than that of the original cane. Then, by courtesy of the Dominion Government, the writer was enabled to tour this district and examine these deteriorating plantations of Cuthbert, Lloyd George, etc. in the company of experts on the staffs of both the Federal and Provincial Department of Agriculture. The observations made during this tour indicated that the occurrence of raspberry mosaic disease in British Columbia appears (on the evidence of field observation) to be extremely rare and its spread very slow. Thus, only two cases of mosaic-infected Cuthbert were identified throughout this tour and in these the symptoms were indistinguishable from, and as clearly visible as those so frequently observed on Cuthbert in Eastern Canada. Further, where mosaic symptoms were observed on other varieties such as Viking, clear evidence was found that the majority of such infections had originated before the recent importation of the cane into British Columbia. It appeared unlikely, therefore, that the present failure in the Lower Fraser Valley of *Cuthbert* and of other varieties was due to an inherent deterioration of the local stocks of cane through mosaic disease. On the contrary, the data collected strongly indicated that this failure should rather be ascribed to a deterioration of the soil following continued raspberry cultivation, than to an inherent deterioration of the variety. This conclusion is also supported by the results of experiments carried out by the Dominion Experimental Farm in the Fraser Valley at Agassiz and valuable work is in progress to determine the precise nature of this soil deficiency and its remedy. Meanwhile the apparently encouraging findings regarding the scarcity of mosaic disease in this district are being further investigated by the Dominion Laboratory of Plant Pathology at Saanichton, B.C., with the object of eliminating existing sources of infection and of ensuring the maintenance of virus freedom of the native cane supplies.

V. The Dominion Government Raspberry Certification Scheme.

We will now return to the Eastern Provinces and States and observe the impressive campaign in progress against raspberry mosaic disease. This campaign aims at (1) the improvement of the stocks of cane of existing commercial varieties by the elimination of mosaic-cane from the sources of cane supply by a system of inspection and certification, and (2) in the breeding of new varieties " resistant " to mosaic disease.

The Dominion Government Certification Scheme was introduced mainly to combat the rapid inroads of mosaic disease into the *Cuthbert* red raspberry and in the first instance inspections were carried out in fruiting plantations which (as in England) also constituted at that time the main source of cane supply to the grower. Latterly, however, the much more efficient method previously practised by some of the leading nurserymen in Ontario of propagating cane in special non-fruiting nursery rows has been recognized and inspections are now wisely limited to such beds.* In Canada cane is still raised by nurserymen for supply to commercial growers although cane nursery rows are also commonly planted on growers' farms, and it was an impressive sight on visiting certain nurseries to see a considerable acreage of land set aside solely for the propagation of virus-free cane. The cane products of certified nursery beds are distinguished by the attachment of official tags and the measure of approval and support accorded to the scheme by the industry was indicated by the fact that the great majority of the growers of the Niagara Peninsula Fruit Belt and other sections in Southern Ontario will not consider the purchase of cane unless it is " tagged ".

* In the United States the propagation of cane in fruiting plantations is still the order of the day and inspections are carried out on such plantations.

It was very interesting to compare the evolution of this large scale cane certification scheme with that of the broadly similar system recently formulated at East Malling. On the one hand the Dominion Government Scheme, as already mentioned, developed from an empirical emergency measure to secure the survival of certain important varieties, to a system aiming at the improvement of the existing commercial stocks of cane of all varieties in current circulation. The East Malling system of cane nurseries, on the other hand, which originated in the normal course of intensive experiments on this group of diseases at the Research Station, aims at introducing and maintaining a *new clonal race* of virus-free *Lloyd George* cane eventually to replace the ordinary deteriorating commercial stocks of cane. The inclusion of other varieties into the scheme will be decided on the basis of their mosaic susceptibility and infectibility, and reliability of field diagnosis, as and when such have been determined by observation and experiment.

The opportunity provided by the exchange period for such a close comparison of the two systems will clearly be of great value in the future development of the scheme at East Malling.

VI. Breeding Mosaic Resistant Varieties.

The great importance of the work of the plant breeder to the raspberry cultivator in North America will already be apparent from the above described limitations of the wide-range varieties *Cuthbert* and *Lloyd George*. We have seen that in North America the native Cuthbert has a much wider range than the immigrant Lloyd George, and it is interesting to note that in England, Cuthbert (although in certain localities it makes satisfactory cane-growth) will not produce a commercial crop of berries. But it would appear that this limitation of each variety outside its country of origin is not due to mosaic disease for we have seen that the occurrence of this disease on Lloyd George in North America is the exception rather than the rule and certainly in the trials at East Malling no correlation between the uniform production of defective berries by Cuthbert and the incidence of mosaic symptoms has been detected. Thus these cases of a general failure of a variety under certain conditions are clearly simply referable to the distinct horticultural potentialities of the varieties in question. Hence it will be seen that the first impetus to the breeder in North America has been to provide varieties with increased natural ranges of adaptability or with a more ideal adaptability to a particular set of conditions among the vast range which are encountered in passing from the Atlantic to the Pacific and from, say, Southern Ontario to Virginia. Many new varieties such as the well-known *Newman* set of seedlings have been raised by growers as the result of the demand for a variety embodying certain specific local requirements (in the case of Newman, increased resistance to the drastic winter conditions of South Western Quebec). But long-range systematic research in raspberry breeding is also in progress at many scientific institutions in Canada and U.S.A. and here the object in mind is the combination by systematic breeding of the above-mentioned desirable horticultural characters with " resistance " to disease, and to mosaic disease in particular. The writer had the privilege of seeing the important work in progress along these lines at the Central Experiment Farm, Ottawa, The Vineland Horticultural Experiment Station, Ontario, the New York Agricultural Experiment Station, Geneva, N.Y., and at the Bureau of Plant Industry, Washington, D.C. At Ottawa a definite system for the trial of new seedlings has recently been adopted by the Division of Horticulture in collaboration with the pathologists of the division of Botany, which includes the artificial infection *in situ* of seedlings in field trial plantations by means of the grafting method used by the

writer in the experimental work at St. Catharines. The Vineland Horticultural Experiment Station has introduced the already famous *Viking* variety, which combines high cropping and fruit qualities with winter hardiness greater than that of *Cuthbert*. Magnificent plantations of Viking were seen in the Fraser Valley as well as in Eastern Canada. In conjunction with the breeding work important research is being carried out at that Station on the causes and control of winter injury.

At Geneva, New York, great emphasis has been placed on the attainment of increased mosaic-resistance (1) because of the extensive growing of the black-raspberry in that State and (2) because of the phenomenally rapid spread of mosaic infection in certain sections. An outstanding example of the latter was seen in the Hudson Valley Fruit Section, New York, a very intensive fruit growing belt on the left bank of the river between Albany and New York, with the New York market for outlet. In this district raspberry mosaic spreads so rapidly that black-raspberries and susceptible red varieties such as *Cuthbert* simply cannot be grown. Consequently one of the most widely grown varieties here is *Latham* which is highly resistant to the disease. *Viking* was under trial when the visit was made, and was giving promising results ; although it is susceptible to mosaic its infectibility was found to be sufficiently low for the plantations to yield commercial crops before they succumbed. Needless to say the propagation of virus-free supplies of cane in the valley cannot be carried out and all cane supplies are brought in from other districts. Trials were also in progress of a newly introduced seedling, *Newburgh*, raised at the Geneva Station. This variety, a cross between the Lloyd George and an American variety appears so far to have a very low infectibility to mosaic, i.e., cases of mosaic even in the Hudson Valley are only rarely found ; such cases, however, indicate that this low infectibility is combined with moderately high susceptibility, for an infected stool rapidly succumbs ; but as long as the low infectibility is maintained this high susceptibility is regarded as a desirable feature enabling easy and rapid elimination of infected stools. The *Newburgh* variety is one of a series of seedlings raised at Geneva which are crosses between *Lloyd George* and an American variety. These seedlings have all shown a markedly low infectibility to mosaic and those engaged in the breeding work informed the writer that such international crosses yield seedlings combining many of the desirable qualities of the *Lloyd George* berry and of the American parent variety with the adaptability to Eastern American conditions which Lloyd George does not possess, and with the added advantage over the American parent variety of a much lower infectibility to mosaic disease such as is shown by the Lloyd George itself in respect of the American mosaics. The valuable work at the Geneva Station on the breeding of black raspberries with low infectibility has already been mentioned. (See p. 158.)

In concluding this section mention must be made of a striking instance of the influence of locality on *susceptibility* to mosaic (rather than on *infectibility* as in the Hudson Valley) which was pointed out in the fruitgrowing district around Amherst in Massachusetts. In the immediate neighbourhood of Amherst the cultivation of the *Cuthbert* raspberry has largely been abandoned owing to the rapid spread and the deteriorating action of mosaic. Some fifteen miles North-East of the town, however, up in a range of hills, is the New Salem district where the native woodland has been cleared and planted up with fruit. Among the fine crops grown by this little fruit farming community the raspberry crop takes a leading place and the variety almost exclusively grown is *Cuthbert*. The original stocks of cane brought in when the land was opened up have been continuously propagated and provide the sole source of cane for present day plantations. No efforts have been made to eliminate mosaic which has spread unchecked with the result that (as I was informed by Dr. Rankin and other experts) at the present time practically all the cane is mosaic infected. In spite of this no marked

general deterioration in vigour has been observed up to the present time, and the plantations are yielding as well to-day as ever.

A Cuthbert plantation twenty-three years old examined at one farm was still producing large crops in spite of the fact that the majority of its stools were mosaic infected. New plantations planted with the products of this plantation were also examined and they were found to be no whit inferior in performance. It was interesting to note that under such conditions, inducing the low susceptibility of a variety usually highly susceptible, the symptoms of mosaic were not nearly so distinct as in other localities. A similar instance was observed in the Lower Fraser Valley, B.C., where Viking plantations with mosaic stools of long standing infection were examined and it was impossible to detect any marked diminution of vigour of such stools under conditions which could clearly be described as horticulturally near the ideal for the variety. The above instances of induced low susceptibility are closely paralleled by the low susceptibility of the Mitchell's Seedling variety in Scotland and the very high susceptibility of the same variety at East Malling, and suggest that the degree of susceptibility of a variety is not by any means absolute, but is largely influenced by the conditions under which it is planted.

Acknowledgments.

In concluding this brief summary of observations and experiments the writer would take the opportunity of expressing his great indebtedness to Dr. E. S. Archibald (Director of the Experimental Farms Branch of the Federal Department of Agriculture), and Dr. H. T. Güssow (Dominion Botanist) for the generous facilities afforded, and for their untiring good counsel during the period spent under their direction ; to Mr. G. C. Chamberlain (acting officer-in-charge) and the staff of the Dominion Laboratory of Plant Pathology, St. Catharines, Ontario, for their constant guidance and generous co-operation throughout the exchange period ; and to the following for considerable help at one time and another : Members of staff of the Divisions of Botany and Horticulture at the Central Experimental Farm, Ottawa ; Mr. E. F. Palmer (Director) and the staff of the Vineland Horticultural Experiment Station ; Mr. W. A. Ross and the staff of the Dominion Entomological Laboratory, Vineland, Ontario ; Prof. D. L. Bailey and other members of the staff of the Department of Botany, University of Toronto ; the many officers of the Federal and Provincial Agricultural Research, Educational and Advisory Services met during tours in Eastern Canada and during the final extended tour to the Canadian West : and finally, to members of the staffs of the many Federal and State Horticultural and Plant Pathological Institutions visited during tours in the United States.

Summary.

The Raspberry Disease situation in Eastern Canada and U.S.A., with special reference to Virus Diseases, is briefly described from observations and experiments carried out during a year's residence at St. Catharines, Ontario, under an exchange arrangement, and is compared and contrasted with that in the Canadian West and in Great Britain.

ENTOMOLOGY

NOTES ON MITE AND INSECT PESTS FOR THE YEAR 1934

By A. M. MASSEE

I. The Hop Red Spider (*Tetranychus telarius* L.).

The Hop Red Spider was a very serious pest in 1921, 1929, 1933, and also in 1934. This mite is able to breed much more rapidly in warm summers, and the years referred to above were particularly favourable for its reproduction.

During the last eighteen months some new and interesting observations have been made on the life-cycle of the Hop Red Spider. In the first place this pest is invariably more common in gardens where pole work is still used. This may be accounted for by the fact that the majority of the mites hibernate in the adult female stage (brick red in colour) in the cracks of the poles. The mites commence to hibernate about hop picking time, in September, or even a little earlier, at the end of August, as they did in 1934. Many of the mites migrate from the leaves to the poles, and these seek shelter in any cracks and crevices they can find. They appear to be particularly fond of hibernating in the small flight holes made by a species of a wood-boring beetle. In addition to hibernating on the poles, a fair percentage hibernate in the soil, in dead leaves, and even in the string which is used for training the hops. Those which hibernate in the soil always select the highest and driest portions of the hop garden.

A number of gardens have been kept under observation for several years, and it has been observed that the red spider attack usually starts in the same part of the garden each year. In fact, it has been possible to forecast where an outbreak of spider is likely to occur, when one has made a survey of the garden the previous summer.

The Hop Red Spider was particularly common in many parts of Kent in 1934, and if next season happens to be a favourable one for the rapid breeding of the mites, there is little doubt that the pest will appear in the same gardens in 1935. Now, it has been the practice of most hop growers in the past to start looking for this pest in July and August, and if it is present in sufficient numbers, spraying operations are carried out against it. According to our present knowledge we must now commence looking out for the pest much earlier in the season. If the grower waits until July, he finds that the mites are well-established, that the fine webs made by the mites protect them against any spray application, and that the eggs of the mite are also present in thousands from July onwards. The small, yellowish-green eggs are deposited on the undersides of the leaves.

It has been established for some years that the spiders hibernate in the poles, in the soil, and in dead leaves, but it has only been discovered recently when the mites become active again in the spring, and commence to reinfest the new bines. The mite leaves its winter quarters during the month of April (in 1934 it was actually observed migrating to its host in the second week) and finds its way to the young bines. At this season they are very active, and they may be seen running up and down the poles during the latter part of April and May, and, what is more important, large colonies are already establishing themselves on the young, tender bines.

An examination of the leaves showed that many of the overwintering females had already deposited their eggs on the undersides of the leaves, and by the end of the first week of May many of the eggs had hatched, and thus new colonies were being established. In addition, the mites had actually started making webs on the under surfaces of the leaves which is an indication that they are becoming fully established.

Every grower will be well advised to examine his hop gardens next May, especially those which were infested last season, and determine whether red spider is present, and then steps should be taken to eradicate it before it becomes established, namely, before the summer eggs are laid, before the mite is protected by the web it produces on the foliage.

It has not been possible to carry out detailed control measures against this mite, but preliminary measures have been investigated and have proved fairly successful.

Apart from spraying measures, it is important to strip all the lower leaves off the bines as soon as possible. The leaves should be collected and burned, because it is on such leaves that the initial colonies are started.

Spraying measures can be carried out without causing injury to the bines, any time during May or June. It is quite safe to spray the variety Fuggles, which is very susceptible to attack.

The spray formula which has been used successfully in 1934 is as follows: Liver of Sulphur 10 ozs., water 100 gallons, sulphonated lorol 6 ozs.

It is important to purchase a fresh sample of liver of sulphur, and the spray should be applied with as much force as possible without damaging the tender bines. The spray should be directed on to the undersides of the leaves because the mites live there, while only a few occur on the upper surface.

In the case of a very severe infestation it will be necessary to apply a second application. This should be put on some seven to ten days after the first application.

If it is found desirable to spray during July or August the amount of liver of sulphur should be increased to 1 lb. per 100 gallons of water, instead of the 10 ozs. recommended for the earlier treatment.

Attempts have been made to destroy the hibernating red spiders in the soil by applying naphthalene at the rate of 3 cwt. of crude commercial naphthalene to the acre, and by spraying the ground with a 5 per cent. concentration of lime-sulphur in the autumn. Both these measures have given negative results.

In one garden where pole work is used, experiments were carried out to see if the spiders which hibernate in the poles could be killed by spraying with a 10 per cent. winter white oil solution. This treatment, however, did not kill the mites, the reason being that the wash did not penetrate into the minute holes and cracks where the mites shelter. However, one very striking observation was made during the investigation. The hop garden concerned, and also another adjoining it, were being very badly attacked each year by a capsid, the Needle-Nosed Hop Bug or "Shy Bug" (*Calocoris fulvomaculatus* De Geer). The attack was so bad in 1932 that several applications of 4 per cent. nicotine dust were applied to keep it in check. This measure by no means eradicated the pest.

In 1933 it was found that one garden, the one in which the poles were sprayed with a 10 per cent. white oil in the autumn of 1932, was completely free of capsid, while the adjoining one which was not sprayed was still badly infested. The infested garden was sprayed in the autumn of 1933, and the Shy Bug has been practically wiped out. There is evidence to show that the capsid lays her eggs in the poles, and that the white oil spray destroyed these eggs.

This is just one more example showing how a very troublesome pest can be eradicated without years of research, first, by studying the habits and life-history of the pest, and then working out methods of control.

II. The Fruit Tree Red Spider (*Oligonychus ulmi* C. L. Koch) on Raspberries and Morello Cherries.

The Fruit Tree Red Spider is a well-known pest of apple and plum, but it is somewhat unusual to find it causing damage to raspberries and Morello cherries.

The Fruit Tree Red Spider proved to be very common on raspberries in Norfolk in 1934. The attack usually started late in the season, about the end of August, and by the end of September, thousands of eggs were deposited on the canes. In one instance the infestation can possibly be accounted for. The raspberries were growing in the same plantation as established standard plum trees. Now, the plum trees were so badly infested with the Fruit Tree Red Spider earlier in the season that they were defoliated by the end of August. It appears that many of the mites fell to the ground with the leaves, and then migrated to the raspberries while searching for food. Others migrated direct from the plums to the raspberries as the food supply on the plums gave out. Although Red Spider has been recorded on cherries several times, there does not appear to be an instance when it has been regarded as being a pest.

This year two reports of severe infestations have been received at East Malling. In addition, the degree of infestation on Morello cherries at East Malling was more severe than usual, and control measures were necessary in one plantation.

III. The Strawberry Tarsonemid Mite (*Tarsonemus fragariae* Zimm.).

The warm summers of 1933 and 1934 have been particularly favourable for the breeding of the strawberry Tarsonemid Mite, and in consequence the mite infestations have been much more severe than usual.

At present it has not been determined how the mite spreads in the field, but the fact remains that it does spread over a wide area, in a short space of time.

This point must be borne in mind, since it means that even if the plants have received the warm water treatment, they will still be subject to reinfection if they are planted near an infested strawberry field. It has not been ascertained how far the mites can travel in one season, but it has been observed that if the plants are isolated they do not become infested in the first year. On the other hand, if they are planted adjacent to an infested plot they invariably become attacked.

IV. Apple Woolly Aphis (*Eriosoma lanigerum* Haus.).

The Apple Woolly Aphis is another insect which is more prevalent during a warm summer, hence the abnormal outbreaks of this pest in 1934. It was reported from all over the country, and reports indicate that it was very common on young trees as well as in the nursery beds. Although this insect may cause some harm to old established trees, one wonders whether it really does cause very much damage elsewhere. It is true that Woolly Aphis is a very important pest in the nursery, particularly where apple stocks are being raised. Not only is the Woolly Aphis important because of its objectionable appearance, but also because of the gall it makes on the shoots. Even if the Woolly Aphis is removed the galls remain, and frequently the market value of the stocks is reduced, because the purchaser thinks the gall is a form of Crown Gall or some other disease.

In some parts of Kent the Woolly Aphis was kept in check by the predaceous insects which prey upon it. The more notable of these are the Seven-Spot Ladybird, the larvae of Lacewing Flies, and the larvae of various species of Syrphids or Hover Flies.

V. The Woolly Aphis Parasite (*Aphelinus mali* Hald.).

The Woolly Aphis parasite was liberated in a three acre apple orchard at Paddock Wood in the spring of 1933. The orchard contained the following varieties of apples, all of which were badly infested with Woolly Aphis: Cox's Orange Pippin, Blenheim Orange, Wellington, Allington Pippin, Newton Wonder and Bramley's Seedling.

Although the parasite was present in some numbers during 1933, it did not spread very rapidly, and by the end of the year it was agreed that a commercial control of the pest had not been obtained, although several parasitized aphids were noted.

The Woolly Aphis continued to flourish in 1934, and as a result the orchard was sprayed twice after the blossom period with nicotine and soft soap.

Later, it was found that the Woolly Aphis almost completely disappeared, the grower naturally thinking that it had been destroyed by the contact sprays. A detailed examination, however, showed that most of the aphids had turned black in colour, and the majority of them had a small round hole in the middle of their backs. It was quite obvious what had happened. Practically all the aphids had been parasitized by the Woolly Aphis parasite. The work of the parasite plus the spraying had mainly accounted for the clean up of the orchard. The parasite must have persisted during the winter of 1933-34, and become well established in the summer of 1934. An examination of the orchard in the first week of October showed that most of the aphids in the orchard were parasitized, and that the parasite had migrated to an adjoining plantation, and was establishing itself there.

VI. The Rosy Apple Aphis (*Anuraphis roseus* Baker).

Since the routine application of tar distillate winter washes on apples has been generally practised, the Rosy Apple Aphis can no longer be regarded as a pest of economic importance. However, some new observations on the life-cycle of this insect in this country are of interest. In the spring of 1934 a number of apple trees growing in pots were put into the insectary. The trees had not received a winter wash, and during May a very severe attack of the Rosy Apple Aphis was noted. Winged forms of the aphid were abundant during the middle of May, and they persisted until the end of June. Quite by chance one plant of the Greater Plantain (*Plantago major* L.) happened to be growing in one of the pots along with several more weeds. It was noticed that the Plantain was literally smothered with immature forms of the Rosy Apple Aphis. They occurred on the undersides of the leaves and also on the stem, the majority being situated near the soil level.

On 15th June twelve plants of the Greater Plantain (*Plantago major* L.) and twelve plants of the Ribwort (*Plantago lanceolata* L.) were collected from the field. These were potted up and placed in the insectary. Almost immediately they became smothered with aphids which definitely appeared to prefer the plantain to the apple. In fact, most of the aphids had left the apples by the end of June and so many of them had migrated to the plantains that some of them were killed.

Once it was established that the Rosy Apple Aphis would feed on plantain as an alternative host to apple under insectary conditions, an effort was made to see if it could be found on Plantain under field conditions.

Both the Greater Plantain and the Ribwort were found growing in and around a derelict orchard near East Malling, and it was found that the Rosy Apple Aphis was present on both these plants. The aphids were not found in large colonies in the field, and were generally present near the ground level ; the base of the stem being a favourite place for them to feed upon.

Plantains have been recognized as being the alternative hosts to apple in the United States and in Canada for many years, but the alternative hosts do not appear to have been recorded in this country prior to 1934.

VII. The Codlin Moth (*Laspeyresia pomonella* L.).

The Codlin Moth has been referred to many times in these notes, and the fact that it is still very common in Kent tends to suggest that it may become an important pest again before long.

Its abundance this year may be due to the suitable weather conditions prevailing and it may be found that one effect of a wet summer will be to check the increase of this pest. However, at the present time it is only too common, as reports from Belvedere, Dartford, Southfleet, Sittingbourne, Maidstone, Canterbury and elsewhere show. It is also common at Lingfield in Sussex.

During the last two or three years the second brood seems to be increasing. In addition to attacking apples, larvae of the second brood also attack pears, and the damage it causes may be quite serious. A bad infestation was noted at Teynham this autumn.

This year there seems to be evidence to suggest that a third brood exists in this country, but this claim will have to be substantiated. Some larvae collected at Lingfield and at Dartford during October were certainly Codlin larvae, and their minute size suggests that they may be the third brood.

Until a good deal more is discovered about the life-cycle of this insect, under English conditions, it is not possible to say very much about control measures. A fair number of larvae are caught in trap bands, and if the bands which are put on the trees to catch the Apple Blossom Weevil, are left intact until November, then the Codlin larvae will go into them for hibernation purposes. Several new types of chemically treated cardboard bands are now being tested, but it is too early to say whether they will be useful for the control of this pest or not.

VIII. The Apple Surface Eating Tortrix (*Cacoecia podana* Scop.).

Although the Apple Surface Eating Tortrix (*Cacoecia podana* Scop.) proved to be the commonest species in 1933, there is reason to suggest that one of the other species causing similar damage to apple fruits may be the commoner species in some seasons.

During the spring of 1934 a limited number of observations were made on *C. podana* Scop. in the field.

On 7th June the writer was fortunate enough to notice an adult female of *C. podana* Scop. settle on the upper surface of an apple leaf, where it proceeded to lay an egg mass, a description of which is as follows : The egg mass was emerald green in colour at first, soon turning a dull green. It was very flat, irregular in shape, and covered by a fine film of skin. It measured 6 mm. × 4 mm. and comprised eighty-eight eggs. The individual egg is approximately the same colour as the leaf, but in some batches the eggs are a trifle more yellowish than the growing leaf. It could be referred to as a yellowish-green colour. The egg is plain, flattened, and more or less pill shaped. The eggs are laid in rows, and the centre ones appear to be a little larger than the rest. The rows

diminish in length towards the sides of the mass. On 18th June the mass changed its colour. The green colour disappeared, the centre of the eggs turned black, and each egg was somewhat swollen.

The first larva hatched out on 19th June. It measured one-twelfth of an inch long. It had a black head and yellow body, the first pro-thoracic plate being pale yellow.

On hatching, the larvae go straight to the under surface of the leaf, and then proceed to cover themselves with a fine silken tent. Next they feed on the foliage. Some of these minute larvae actually make a little silken tunnel, and live inside this form of protection. The larvae do not merely feed on the outer layers of the foliage, but before they are many days old they are able to pierce right through the leaf to the upper surface. After some days they stick two leaves together by means of silk threads, and there they continue to feed and develop in this protected and sheltered position. A few larvae were noted feeding on the upper surface of the leaves, causing a type of damage similar to that caused by the Apple Leaf Skeletonizer.

Another egg batch was laid on a leaf in the field on 24th June. The larvae hatched from the eggs of this batch on 7th July. On hatching, the larvae soon spread to different parts of the tree. Some migrated by crawling from leaf to leaf, while others were carried by the wind suspended by silken threads.

In 1934 the moths of *C. podana* Scop. were noted in the field from the end of May until the beginning of July, and there is evidence to show that eggs are being laid over this period also. With such an extended egg-laying period, control measures may prove to be difficult to attain.

Lead arsenate sprays do not seem to have any appreciable check to the larvae in the spring, and in a normal season they would not be applied as late as the end of June, the time when the young larvae start to emerge.

From our present knowledge it seems likely that an extra spray or dust will have to be applied in July, at the period when egg laying is finished, but before the larvae protect themselves so efficiently by sticking two leaves together, and by sticking a leaf to the surface of an apple, and feeding on the fruit surface.

IX. Plum and Cherry Bark Beetle (*Eccoptogaster mali* Bht. and *Eccoptogaster rugulosus* Rz.).

Both the above species of bark beetles were reported last season, *E. mali* being particularly common at Goudhurst where it was found attacking plums and cherries.

E. rugulosus was noted at East Malling where it was very common on some old and neglected damson trees. It also occurred at Otham, near Maidstone, where it was infesting some young standard Victoria plum trees.

Once a tree is badly infested with a species of Bark Beetle there seems to be little hope of eradicating it, but some measure of success was attained by spraying the trunks of the trees with a 10 per cent. tar-oil emulsion during the " flight period " of the beetles, namely in April or May.

X. The Apple Fruit Rhynchites (*Rhynchites aequatus* L.).

The Apple Fruit Rhynchites, an active red weevil, with a long snout, which disfigures the developing fruitlets by boring in the flesh, was reported from many sources four years ago. This year it has been causing more damage than usual in many parts of Kent. It has been common at Swanley, Malling, Maidstone, Chartham, the Weald of Kent and many other places.

This weevil usually attacks the apple fruitlets about ten days to two weeks after petal fall. It remains on the tree for several weeks, and then moves off elsewhere. Although experimental work has not been carried out on the control of this pest, it is known that the application of a single derris dust will destroy this insect. It should be applied about two weeks after petal fall, or as soon as the damage is detected on the fruitlets.

XI. Apple Grafts Attacked by the Weevils (*Otiorrhynchus singularis* L. and *Otiorrhynchus clavipes* Bf.).

Although there is quite a simple remedy for preventing apple grafts from being attacked by these weevils, instances of damage are frequently reported each season from different parts of Kent. This year reports were received from Southfleet and the Canterbury district. Now, when the grafts are put on, they can be protected by painting them with lead arsenate, which should be made up into a fairly thick paste, and applied by means of a brush.

Another way of dealing with these weevils is by greasebanding the tree. Weevils of this group do not possess wings, and are therefore unable to fly. They must gain access to the grafts by crawling up the trunks, and a ring of grease will prevent them from doing this.

XII. Beetle Larvae Attacking the Roots of Strawberries.

Damage caused to strawberry plants by beetle larvae feeding on the roots have been sent in from Ryarsh, West Farleigh, Malling and from Norfolk. The type of damage caused by these insects is quite typical. The plants begin to wilt, then finally flop and eventually die. The attacks are usually noticed in June and July, but the larvae must have been feeding before this period in some cases, and by June the amount of feeding is sufficient to affect the plant.

Several species of beetles are associated with this type of damage, the more important being the " June Bug " (*Melolontha vulgaris* F.) ; the Clay-Coloured Weevil (*Otiorrhynchus singularis* L.) ; and the Vine Weevil (*Otiorrhynchus sulcatus* L.). In addition, the larva of the Ghost Swift or " Otto " Moth (*Hepialus humuli* L.) sometimes causes damage to the roots.

The above pests are usually more common on land which has been grassed down previously, but where the attack occurred at Ryarsh, the land had been cultivated for many years.

XIII. Apple Fruits Destroyed by the Cockchafer (*Phyllopertha horticola* L.).

The garden chafer caused considerable damage to the fruits of Cox's Orange Pippin apples, in a bush orchard at Chartham, by feeding on the fruits. Literally thousands of these Chafer beetles were present in the month of June, and it was not uncommon to find three beetles feeding on a single fruitlet. On sunny days they fly about quite strongly, but on dull days they concentrate on feeding on the fruits. The damage they cause is very serious ; a fruit nibbled by a chafer is quite useless. Unfortunately, a single beetle is not content to devour a whole fruit. In practice it eats a piece out of the fruit about the size of a threepenny piece, and then moves off, and attacks a fresh one.

The attack lasts for several weeks, and so far it has not been possible to check the invasion which appeared daily. A thorough spraying with arsenate of lead did not seem

to deter the chafers, and they continued to feed until they disappeared naturally. A derris dust was also used, but this proved to be equally ineffective.

There is no doubt that in this case the larvae of the Chafers were breeding in the loose sandy soil beneath the trees. This is an ideal situation for them, more especially because tufts of coarse grass were abundant, and the larvae feed upon the roots of various kinds of grasses.

Further reports of damage by these beetles were received from Maidstone, in Kent, Surrey and Norfolk. The attack in Surrey was particularly severe.

XIV. The Pear and Cherry Slugworm (*Eriocampa limacina* De Geer.).

The Pear and Cherry Slugworm has been recorded many times attacking pears and cherries, more particularly along the coastal towns of Kent.

This season it has been very common on Morello cherries in the Sittingbourne area. It has also been reported on pears in other parts of Kent.

Fortunately this pest is quite easy to eradicate. The application of a nicotine or lead arsenate dust about the end of July is sufficient.

Summary.

Brief notes are given of some of the more important species of mite and insect pests which were reported in 1934.

Those referred to include the Hop Red Spider, the Strawberry Tarsonemid Mite, the Apple Woolly Aphis, the Rosy Apple Aphis, the Codlin Moth, the Apple Fruit Rhynchites, Beetle larvae attacking the roots of strawberries, and the Garden Chafer feeding upon the fruits of apple.

NOTES ON THE STRAWBERRY APHIS (*CAPITOPHORUS FRAGARIAE* THEO.)

By A. M. MASSEE

Investigations were commenced in the autumn of 1933 to obtain further information upon the life-cycle and the alternative hosts of the common strawberry aphis.

The strawberry aphis was described by Theobald in 1912 (1) under the name of *Myzus fragariae* Theo., and was assigned the popular name of the Delicate Strawberry Aphis. At that time Theobald did not consider the aphis to be an economic species, and apart from the fact that it occurred on cultivated strawberries in Middlesex and Sussex, little was known about it.

In 1927 Briton-Jones and Staniland (2) described some investigations they made concerning the effects of the strawberry aphis (*C. fragariae* Theo.) on the strawberry plant. They considered the aphis to be an important species, and that the direct injury caused by this insect might, under certain conditions, be very detrimental to the plant.

In the same paper they refer very briefly to the life-cycle of the aphis, and mention that it was found on the plants in January, 1926, after several weeks of extremely severe frosts. They also noted that, under glass-house conditions, winged forms were produced in the autumn. The egg stage was unknown.

The strawberry aphis has been noted in the Maidstone district for many years, but it has not proved to be very common until 1933 and 1934. In those years it has been abnormally abundant.

The aphis lives on the cultivated strawberry from the latter part of August until the following July. It is sometimes common during the winter months, where it may be found on the under surfaces of the leaves in January and February, even during severe frosty weather and when the strawberry fields are in a waterlogged condition. They do not seem to breed much before the spring months, during which period they become much more abundant. Winged forms appear in July, and it is evident that the majority migrate elsewhere, since very few can be found on the plants at this period. It is not clear whether they migrate in July and find an alternative host plant, or whether they simply fly away and die, leaving a few wingless forms behind them to start new colonies on the strawberry plants. It is significant that a few aphides may be found on the plants all the year round.

Seven species of aphides have been recorded on cultivated strawberries by different authorities. Of these the strawberry aphis is referred to by five different names, and three other host plants are mentioned in addition to the cultivated strawberry (5). Theobald and Davidson (3) refer to *Fragaria vesca* L. as being a host plant, while Hille Ris Lambers (4) includes *Potentilla anserina* L. and Davidson (3) also refers to *Centranthus ruber* D.C. Hille Ris Lambers, however, doubts whether *C. ruber* is really a host plant of the strawberry aphis.

The following table gives a list of the species recorded on strawberry, together with their synonyms, host plants and localities. This list has been drawn up from the records of Theobald, Davidson and Hille Ris Lambers.

A List of Aphides Recorded on Cultivated Strawberry, together with Synonyms, Host-Plants and Localities.*

Name of Species.	Synonyms.	Host Plants.	Localities.
Macrosiphum rosae L.	*Siphonophora rosae* Koch. *Siphonophora fragariae* Koch. *Macrosiphum fragariae* Theo. *Aphis dipsaci* Schrank. *Siphonophora scabiosae* Buckton, etc. *Aphis rosae* L. *Nictophora rosae* Oestl. *Macrosiphum centranthi* Theo.	All kinds of roses, Red Valerian, *Bidens*, *Dipsacus* sp., *Scabiosa*. Apple, Tomato. Rhododendrons (Theobald). *Fragaria vesca* (Davidson). *Fragaria vesca* (Hille Ris Lambers).	England, including Kent.
Pentatrichopus potentillae Wlk.	*Capitophorus fragariae* Theo. *Myzus fragariae* Theo. *Myzus (Capitophorus) fragaefolii* Cockll. *Aphis potentillae* Wlk.	*Fragaria vesca* (Theobald). *Fragaria vesca* (Davidson). *Potentilla anserina* (Hille Ris Lambers).	England, including Kent. U.S.A.
Aulacorthum or *Acyrthosiphum rogersii* Theo.	*Macrosiphum rogersii* Theo.	*Fragaria vesca* (Theobald).	England. Middlesex.
Macrosiphum solanifolii Ashm.	*Siphonophora fragariae* Buckton. *Macrosiphum centranthi* Theo. *Macrosiphum gei* (Koch) Theo. *Macrosiphum amygdaloides* Theo. *Macrosiphum sileneum* Theo. *Macrosiphum euphorbiellum* Theo. *Macrosiphum hellebori* Theo. & Walton. *Macrosiphum crulii* Davis. *Macrosiphum epilobiellum* Theo. *Macrosiphum stellariae* Theo. *Macrosiphum citrifolii* Ashm.	Nearly omniphagus. Quite common on Strawberries.	England, including Kent.
Amphorophora (*Eunectarsiphon*) *rubi* Kalt.	*Amphorophora fragariella* Theo. *Siphonophora fragariella* Theo. *Macrosiphum fragariellum* Theo. *Aphis rubi* Kalt. *Siphonophora rubi* Koch. *Nectarosiphum rubi* Schout. *Rhopalosiphum rubi* V. de Goot. *Eunectarsiphon rubi* Del Guerc.	*Fragaria vesca* (Theobald). *Epilobium montanum*, *Geum urbanum*, *Rubus fructicosus*, *Rubus idaeus*, *Sarothamnus scoparius* (Davidson).	England, including Kent.
Cerosipha forbesi Weed.	*Aphis forbesi* Weed.	*Fragaria vesca*.	U.S.A. France. Italy. Germany.
Pentatrichopus brevipilosus Baey.	Nil.	*Fragaria* sp.	U.S.A.

It will be seen from the table that a great deal of confusion exists regarding the names of the species, and it is just another example indicating how difficult it is for the Economic Entomologist to be quite certain which species of insect he is working with, and whether colleagues elsewhere are experimenting with the same insect or an entirely different species.

* This list has been compiled in the main from Theobald's *The Plantlice of Great Britain*, Davidson's *A List of British Aphides*, and from Hille Ris Lambers' *Notes on Theobald's "The Plantlice or Aphididae of Great Britain."*

As already mentioned, the strawberry aphis is referred to by five different names, and if the compilation of the table is accurate, then the American species *Myzus* (*Capitophorus*) *fragaefolii* Cockll. and the English species *Capitophorus fragariae* Theo. are identical, and both should be referred to by the name *Pentatrichopus potentillae* Wlk. Until this point has been finally settled by the systematic entomologists, however, it is proposed to retain the name *Capitophorus fragariae* Theo. for the English species.

Once it was known that the strawberry aphis had been recorded on three additional host plants, experiments were undertaken at East Malling to determine whether it occurred on these plants in this country.

In November, 1933, twelve plants each of the following varieties, obtained from various sources in Kent, were potted up and kept in a heated greenhouse : *Potentilla reptans* L. (Cinquefoil) ; *P. sterilis* Garcke. (Strawberry-leaved Potentilla) ; *P. erecta* Hampe. (Tormentil) ; *P. anserina* L. (Silver-weed) ; *Fragaria vesca* L. (Wild Strawberry) ; *Centranthus ruber* D.C. (Red Valerian) and *Rosa canina* L. (Dog-rose). The plants were kept on a staging and were so arranged that no two plants of the same species were adjacent to each other. Twenty-four aphis-infested Royal Sovereign plants were stood amongst the Potentillas, etc. but were so spaced that they did not actually touch them.

The aphides began to breed in January (under the influence of the greenhouse heat) and strong colonies were soon produced. A few of the aphides were found on the Cinquefoil plants early in January, and by the second week some numbers had migrated to the Silver-weed plants. By the second week of March, well established colonies were present on all the Silver-weed plants, and a few were still feeding upon the Cinquefoil plants, although they did not produce large colonies on this host.

The mode of migration to the Silver-weed and Cinquefoil plants was not discovered. Winged forms were not present, and none of the plants was touching the one adjacent to it. It can only be assumed, therefore, that some of the aphides were wandering about on the staging, and those which happened to come into contact with the Silver-weed and Cinquefoil plants established themselves.

By the end of March a few aphides were noted on the Strawberry-leaved Potentilla and on the Tormentil plants, and a few days later aphides were establishing themselves on the Wild Strawberry. In addition, a few aphides were found wandering about on the Red Valerian plants, but they did not become established on this host. The aphis apparently found the Wild Rose unpalatable, for although aphides were placed on the plants from time to time they did not attempt to feed and all perished within a few days.

During April, the aphis population increased very considerably, and by that time it was quite obvious that the aphides preferred the following hosts : (1) Cultivated Strawberry, (2) Wild Strawberry, (3) Silver-weed, and (4) Strawberry-leaved Potentilla. A few aphides were still present on the other plants, but they only occurred very sparingly.

Winged forms were first noted on the 24th March and they still persisted at the end of April. Under glasshouse conditions strong colonies were present until the end of August, but after this date the aphides became very scarce and only a few were to be found.

In the field, however, the aphis population dropped considerably after 15th July, but it increased again in October.

During the period from December, 1933, until January, 1935, a constant search was made to find the egg stage, but eggs were not found in the greenhouse or in the field.

Once it was established that the aphis would feed quite readily and form colonies on the Wild Strawberry, Silver-weed and on the Strawberry-leaved Potentilla, it seemed

reasonable to suppose that it might also be found on these plants growing under natural conditions. Therefore, a search was made in the neighbourhood.

An ideal site was found adjoining a wood at East Malling. About two acres of land (now derelict) had been planted with Royal Sovereign plants some five years ago. The ground was not cultivated and as a result many kinds of weeds were growing there. Amongst them were the Strawberry-leaved Potentilla, the Wild Strawberry, odd plants of Silver-weed and also the remains of the cultivated strawberry.

These plants were searched systematically over a long period, but the strawberry aphis was not found on any of them, with the exception of the cultivated variety. It was thought that the aphides might migrate to the other hosts in July, when it naturally leaves the cultivated strawberry, but it certainly did not do this in 1934. The roots of the plants were examined in addition to the foliage, but as already indicated, aphides were not found on them.

From the above notes it will be observed that there is still a great deal to be discovered about the strawberry aphis, for example, the egg stage is not known, nor are the alternative hosts under natural conditions.

The writer is indebted to Mr. F. J. D. Thomas for his assistance in drawing up the table, and to Dr. Hille Ris Lambers for going through the list of species referred to and making valuable suggestions.

Summary.

Some brief notes upon the life-cycle of the Strawberry Aphis are presented.

Experiments show that the aphis can be induced to form colonies on various host plants under glasshouse conditions.

Among these, the Wild Strawberry, the Strawberry-leaved Potentilla and the Silver-weed seem to be the ones most preferred by the aphis.

The aphis will also feed on other hosts to a lesser degree.

The aphis has not been found on plants other than the cultivated strawberry growing under natural conditions.

The egg stage of the aphis is as yet unknown.

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APPENDIX

Bibliography of Papers dealing with Aphids on Strawberries

By F. J. D. THOMAS

CONSIDERABLE interest is now being taken in the Aphids found on strawberries, as a result of recent virus transmission work. It was therefore thought worth while drawing up the following list of publications dealing with aphids on strawberries, in the hope that it might assist other workers, both at home and abroad. It was drawn up largely from the pages of the *Review of Applied Entomology*, and while it is as complete as possible, it has no claims to be exhaustive.

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APPLE BLOSSOM WEEVIL EXPERIMENTS IN 1934

IMPREGNATION OF TREE BANDING MATERIALS

By R. M. GREENSLADE, A. M. MASSEE AND F. J. D. THOMAS

INTRODUCTION.

This experiment was designed to determine whether the corrugated cardboard bands (which are used extensively for trapping the Apple Blossom Weevil, *Anthonomus pomorum* (L.) Curt.) could be successfully treated with various impregnants to render them distasteful to birds, mice, etc., which frequently destroyed them; also to determine the effect of the chemical compounds upon the living tree, and to ascertain whether any of the treatments acted as attractants or repellants to the weevils.

In addition, it has proved possible to obtain some valuable data on the effect of certain chemicals upon the Codlin Moth larvae which frequently hibernate in the bands from the autumn months onwards.

NATURE OF THE EXPERIMENT.

Since the effect of the various treatments upon the living tree was not known, the majority of the corrugated cardboard bands were placed round hop poles which were used as supports in a cordon orchard where Apple Blossom Weevil has been a serious pest for many years.

In order to determine whether any of the treatments had any detrimental effect upon the bark of the trees, an average of twelve bands of each treatment were actually put on the stems of the cordons. The bands were put on the poles and trees on 26th and 27th June, 1934. A total of 742 bands were placed on the poles, and 117 on the stems of the cordons.

The following treatments were used in the investigation* :—

Treatment No.	
1–2	50% solution of " Seekay " Wax A 68 in trichlorethylene.
3–4	50% solution of " Seekay " Wax A 93 in trichlorethylene.
5–6	33% solution of " Seekay " Wax A XIII in trichlorethylene.
7–8	33% solution of " Seekay " Wax A 123 in trichlorethylene.
9	10% solution of " Seekay " Wax A 68 in orthodichlorbenzene.
10	Solution containing 10% " Seekay " Wax A 68 and 30% paradichlorbenzene in trichlorethylene.
11	20% solution of " Seekay " Wax in creosote oil.
12	7% solution of tetrachlorbenzene in trichlorethylene.

Some of the treatments affected the bands and rendered them somewhat difficult to put on. The following notes indicate the effect the treatments had on the bands at the time of application to the poles and trees.

Treatment Nos. 1–2. The corrugated cardboard was somewhat flabby and was inclined to tear, and the material was inclined to come off in one's hands. Not objectionable to apply.

* The preparations used were supplied by Imperial Chemical Industries Limited. At present they are only under trial and not yet on the market. The " Seekay " Waxes are a series of chlorinated naphthalenes.

Treatment Nos. 3–4. Bands went on easily. Not quite so oily as treatments 1–2.

Treatment Nos. 5–6. Bands went on easily. Not sticky. Bands somewhat brittle, but not so brittle as to be detrimental.

Treatment Nos. 7–8. Very easy to handle. Not brittle. Not oily.

Treatment No. 9. Very easy to handle. Firm. Not brittle. Not oily.

Treatment No. 10. Not quite so easily handled as No. 12. Firm. Smell affects one while putting on bands.

Treatment No. 11. Bands very oily and greasy. Not nice to handle. Firm.

Treatment No. 12. Bands very easy to handle. Not sticky. A little brittle, but not enough to affect the bands. Firm.

Damage to Bands by Birds, Mice, etc.

Records of damage to the bands by birds, mice, etc., were taken at weekly intervals from the end of June up to the middle of October.

Unfortunately only a very small percentage of the bands (whether control or treated) were damaged, and it has not been possible to obtain any reliable information on this aspect of the investigation. Some twenty bands out of a total of 405 bands in the control series were attacked by birds, but the damage was not serious. One or two bands of each of the treatments were also slightly bird-pecked, but the damage proved to be negligible.

Damage to the Trees.

An average of twelve bands of each treatment were put directly on to the stems of the cordons. When the bands were removed in October a careful survey was made to determine whether any of the treatments had any injurious effect upon the bark, or living tissue of the trees. None, however, was detected, and it would appear that it is safe to apply the bands directly to the bark without fear of causing injury. As a matter of fact the bands were tied very tightly to the stems, so that if any of the treatments was likely to cause injury to the bark one would expect to detect it after the bands had been *in situ* for four months.

Removal of Bands.

All the treated bands on the poles and the cordons, and also the control bands, were removed on 25th, 26th and 27th October.

As each band was removed, details were obtained of the number of weevils per band, the number of weevils left behind on the pole or tree, and in addition records were obtained of the number of Codlin Moth larvae present per band. Notes of other interesting insects present were also obtained.

The experiment was so arranged that every other band in the row was a " control " band. Thus the untreated bands were scattered about all over the plot.

Table No. I presents a full summary of averages for the bands round the poles.

In the first place it will be noted that the control bands (405 in all) averaged 9·6 weevils per band, and as a matter of fact the distribution of the weevils in the control bands proved to be fairly uniform throughout the plot.

The Effect of the Treatments upon the Weevils.

The outstanding treatment in the experiment proved to be treatment No. 5–6 (33 per cent. solution of " Seekay " Wax A XIII in trichlorethylene). This treatment

Table I.

Summary of Averages for Bands Round Poles, 1934.

Treated and Controls. Rows 1-21.

Rows	Treatment No.	Total No. of Bands.	Apple Blossom Weevils		Codlin.
			in band.	on pole.	
1 to 21	Controls	405	9·6	1·7	0·2
18 and 19	1	36	0·78	0·2	0·2
4 and 5	2	28	1·5	0·1	0·4
16 and 17	3	36	2·0	0·9	0·3
1, 2 and 3	4	38	4·0	1·2	0·7
10 and 11	5	36	20·4	3·0	0·4
14 and 15	6	36	16·4	4·7	0·2
20 and 21	7	36	5·7	1·9	0·3
12 and 13	8	36	8·6	1·6	0·2
8	9	15	1·8	1·1	0·4
7	10	14	2·3	0·7	0·1
9	11	14	0·0	0·1	0·2
6	12	14	9·0	1·1	0·1

seemed definitely to attract the weevils since, as will be seen in the table, the bands on rows 10 and 11 contained 20·4 weevils per band, and those on rows 14 and 15 contained 16·4 weevils per band. This is double the number trapped in the control bands.

In treatment No. 12 (7 per cent. solution of tetrachlorbenzene in trichlorethylene) an average of nine weevils were caught in the bands, the same number as in the controls, so it would appear that this treatment at least is not objectionable to the weevils. Treatment 7–8 (33 per cent. solution of "Seekay" Wax A 123 in trichlorethylene) attracted nearly as many weevils as the control bands, and it certainly proved to be one of the more outstanding treatments in the trial.

There is not the least doubt that some of the preparations were obnoxious to the weevils, and these treatments actually deterred the weevils from going into the bands. It was also noticeable that some of the treatments (which will be referred to below) prevented other insects, i.e. earwigs, larvae, etc., and spiders from attempting to shelter in the bands.

The following treatments did not attract the weevils, and it is considered that in any future trial they need not be included, at least where Apple Blossom Weevil is concerned, but some of them must be tested again in any future Codlin trial. Treatment 1–2 (50 per cent. solution of "Seekay" Wax A 68 in trichlorethylene); treatment 3–4 (50 per cent. solution of "Seekay" Wax A 93 in trichlorethylene); treatment No. 9 (10 per cent. solution of "Seekay" Wax A 68 in orthodichlorbenzene); treatment No. 10 (solution containing 10 per cent. "Seekay" Wax A 68 and 30 per cent. paradichlorbenzene in trichlorethylene); and treatment No. 11 (20 per cent. solution of "Seekay" Wax in Creosote oil).

The last column of Table No. I gives the average number of Codlin Moth larvae per band. While it will be noticed that the numbers are small, one or two of the treatments seem definitely to attract the larvae, and the majority of them appear to have attracted as many as, or more, larvae, than the control bands. In this respect treatment No. 3–4 is outstanding, while treatments No. 9 and 12 did not contain as many Codlin larvae per band as the controls. Treatment No. 3–4 did not attract as many weevils as some

of the other chemically treated bands, but it is evident that this is one of the treatments which must be tested again next season in view of the number of Codlin larvae attracted to the bands.

With a few exceptions there was not much variation in the number of weevils hibernating on the poles beneath the bands, but it is of interest to note that a greater number was present on the poles in treatment No. 5–6, which incidentally is the treatment which attracted most weevils into the bands.

Table II records the total number of weevils, and the average number of weevils caught in the bands which were put round the stems of the cordons. The number of Codlin larvae found in the bands is also recorded.

TABLE II.

SUMMARY OF TREATED BANDS (ROUND TREES), CORDONS, 1934.

Treatments 1-12. *Rows* 2-21. 27/10/34.

Rows	Treatment No.	Total No. of Bands.	Apple Blossom Weevil.		Codlin.	
			Totals for Bands.	Average per Band.	Totals for Bands.	Average per Band.
18 and 19	1	11	7	0·6	10	1·0
4 and 5	2	12	14	1·2	25	2·1
16 and 17	3	12	34	2·9	14	1·2
1, 2 and 3	4	11	36	3·3	19	1·6
10 and 11	5	12	190	15·8	6	0·5
14 and 15	6	12	245	20·4	14	1·2
20 and 21	7	12	91	8·4	12	1·0
12 and 13	8	12	62	5·2	6	0·5
8	9	5	7	1·4	4	0·8
7	10	6	22	3·7	3	0·5
9	11	6	0	0·0	2	0·3
6	12	5	56	11·2	1	0·2

It will be noted that in treatment 5-6 the bands again contained most weevils, which materially supports the suggestion that this treatment must attract the weevils to the bands. It has been shown already that this treatment was superior to any other in the previous experiment.

Treatment 7-8 also appears to be very promising since rows 20 and 21 had an average of 8·4 weevils per band, which is a good deal better than the average for the majority of the treatments.

Treatment 12 also proved to be good; thus it will be seen that the three treatments which produced most weevils from the bands on the poles, also produced more weevils from the bands around the stems of the cordons.

None of the treatments seem to deter the Codlin Moth larvae from hibernating in the bands, and the figures do not suggest that the larvae have any preference for any particular treatment.

THE EFFECT OF THE TREATMENTS UPON THE WEEVILS.

All the weevils which were collected from the treated bands were kept in glass-top boxes and were placed in an incubator at a constant temperature of 22° C. The warm conditions of the incubator made the weevils active, thus it was possible to detect whether any of the treatments affected the weevils in any way.

Treatment 5-6 which attracted most weevils did not cause any mortality; in fact the weevils were very active, and were not affected in the least degree. Treatments 7-8 and 12 also did not appear to cause any mortality to the weevils.

Now some of the treatments which actually kept the majority of the weevils away from the bands, did kill the small proportion which ventured into them. For example, all the weevils in the bands of treatment No. 1-2 were dead, and so were those found in the bands of treatments 9-10.

The weevils collected from the bands of the remainder of the treatments were still alive at the end of November, but it is possible that many of them will die before the spring of the year.

The Effect of the Treatments upon Codlin Larvae.

The majority of the Codlin larvae which hibernate in the bands pass the winter as a larva enclosed in a very compact, neat cocoon. The cocoon is made either from portions of the bark, or, if resting in the bands, the cocoon is made up with pieces of the band. Thus one might expect that some of the treatments at least would affect the larvae in some way. This did not prove to be the case, however, and at the time of writing, the larvae have not been affected by any of the treatments.

Conclusions.

Since none of the treatments had any injurious effect upon the stems of the trees, it will be possible to repeat some of the treatments next year on a field scale. The treatments which have proved very promising include the following. Treatment 5-6 (33 per cent. solution of "Seekay" Wax A XIII in trichlorethylene); treatment 12 (7 per cent. solution of tetrachlorbenzene in trichlorethylene); and treatment 7-8 (33 per cent. solution of "Seekay" Wax A 123 in trichlorethylene). The results indicate that treatment 5-6 actually attracted the weevils into the bands, and the tables show that double the number were caught in the bands of this treatment as compared with the controls. Treatments 12 and 7-8 were equally as good as the controls. It is not considered that any of the other treatments are worthy of further trial on a field scale.

Since the Codlin Moth problem is becoming a very serious one, and as some American authorities have shown that chemically treated bands can play an economic part in the control of this pest, it seems desirable to continue the preliminary trials for another season at least. This season's results are extremely encouraging. They indicate that none of the treatments prevent or deter the Codlin larvae from hibernating in the bands, and as in the case of the weevil trials, some of the treatments actually encourage the larvae. It is considered that all the treatments should be included in next season's trial.

Summary.

Details are given in the form of a progress report of the results obtained in the first season's work in relation to the impregnation of weevil corrugated trap bands with various chemicals.

Some of the treatments have been found to attract not only Apple Blossom Weevils, but also larvae of the Codlin Moth.

None of the treatments caused any damage to the bark or trunks of the trees.

The more promising treatments will be tested again in 1935.

LABORATORY TRIALS OF WETTERS AGAINST WOOLLY APHIS *ERIOSOMA LANIGERUM* (HAUSM.)

By R. M. GREENSLADE

Introduction.

Colonies of Woolly Aphis in the natural state are protected by a mass of fine threads of wax which are secreted by four rows of glands along the back of each insect and become interlaced over the top of the colony. This mass of wax threads is extremely difficult to wet because of its waxy nature and the fineness of the threads. Most spray liquids will not penetrate this "wool" without force, so that unless each colony is actually hit by the spray the liquid runs over the top of the colony without wetting or wets only the outside layers of threads, forming a "mat" under which the aphides remain dry. The aphis itself is easily killed by nicotine so that its control by wet spraying is entirely a question of efficient wetting. A number of substances known to have wetting properties were tested in the hope of finding one suitable for Woolly Aphis. Most attention was given to wetters suitable for spring and summer use in the hope of finding a wetter suitable for use with spring lime-sulphur Scab sprays, but three winter washes were also included.

These materials were tested in the laboratory with a view to selecting any which might be worth a trial on a field scale. In the first place an attempt was made to spray colonies of aphis on cut shoots of apple using the per cent. kill as an index of the efficiency of wetting. It was found difficult to obtain an even distribution of spray and the method was wasteful of insect material which was not available in very large quantity, so finally cut shoots infested with aphis were dipped in solutions of the various preparations. Nicotine at a concentration of 4 ozs. per 100 gallons (0·025 per cent.) was added to all except the winter washes. A preliminary experiment had indicated that no advantage would be gained from using a higher concentration. One preparation was also tested without nicotine as it was known to have some insecticidal action.

Methods of Testing.

In order to test the efficiency of this dipping method several series of dippings were done at a large range of concentrations with soft soap and with tar-oil. Twigs infested with Woolly Aphis were immersed for ten seconds each and the number of aphides killed was counted after twenty-four hours. Each individual colony was counted separately so that each colony becomes in effect a replication of the experiment. The per cent. kill for each concentration was calculated as the mean of the kills for separate colonies at that concentration. The material used was collected in the field and was as uniform as possible.

The results of these experiments are shown in Tables I and II and Curves I and II.

TABLE I.

PER CENT. KILL OF SOFT SOAP SOLUTIONS WITH AND WITHOUT NICOTINE.

Concentration (per cent.)	% kill with nicotine.	Standard error.	% kill without nicotine.	Standard error.
0·1	1	0·5	1·3	0·6
0·2	3·5	2·6	1·7	1·1
0·3	2·5	1·1	1·8	1·3
0·4	12·5	6·3	0·9	0·4
0·5	10·3	2·6	4·5	1·3
0·6	25·3	4·3	17·3	6·8
0·7	46·8	7·7	13·8	2·8
0·8	66·9	7·1	10·1	1·6
0·9	75·8	5·7	12·6	2·9
1·0	76·6	4·7	18·7	4·4
1·2	91·1	3·0	20·0	5·2
1·5	98·1	1·1	39·7	8·5
2·0	96·0	1·5	51·3	8·8
2·5	96·2	1·2	87·3	3·0
3·0	96·6	1·4	79·5	6·0

TABLE II.

PER CENT. KILL OF TAR-OIL EMULSIONS.

Concentration (%).	Per cent. kill.	Standard error.
2	2·8	1·35
4	8·4	3·18
5	16·25	2·60
6	33·23	5·55
7	44·45	5·17
8	61·43	3·85
10	72·57	4·41
12	89·61	3·15
14	88·71	4·16
16	97·41	1·23
18	97·41	1·31
20	99·46	0·31

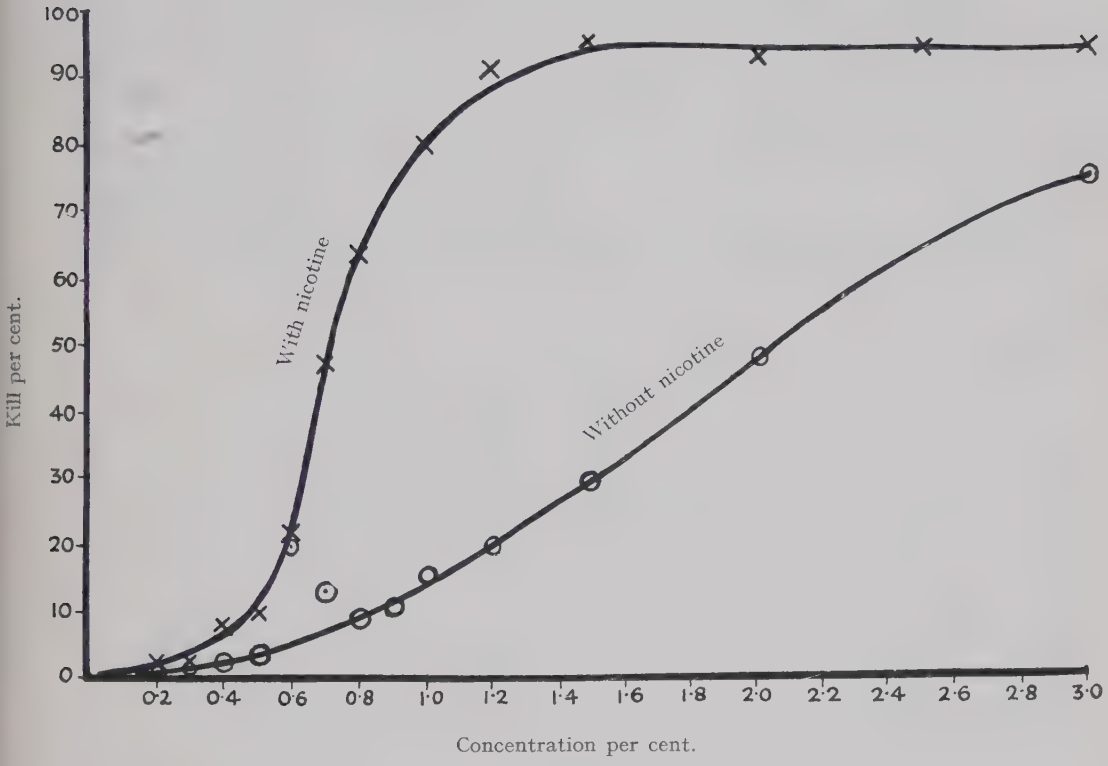
Statistical examination of these two experiments showed that with the insect material available the method was sufficiently accurate to be used for the comparison of substances of unknown wetting power. It was found that variations in number of aphides per colony and amount of wool present made little difference at the higher kills and it was only those preparations giving a high kill that were of interest.

MATERIALS TESTED.

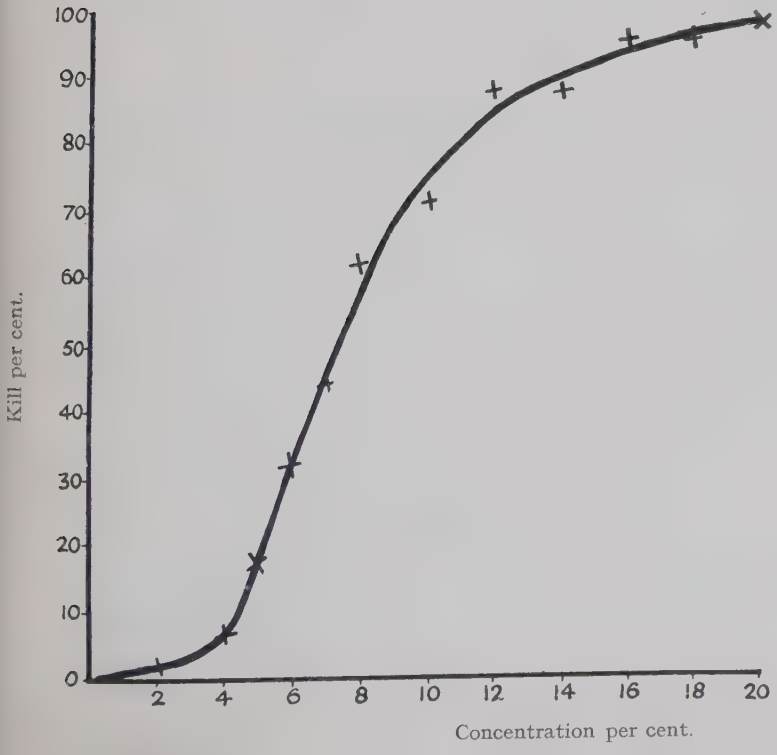
This method was used to test the following preparations :

Agral N, a sulphonate of an alkylated cyclic hydrocarbon.
Agral I, a diluted form of Agral N.
Agral II (R.D. 4206), a chemical variant of Agral I.
R.D. 4117, a long chain alkyl quaternary ammonium salt.
Sulphonated lorol, mainly the sodium salt of sulphated lauryl alcohol.
Lissapol A, a sulphate of a long chain alcohol.

Curve I. Wetting Power to Woolly Aphis of Soft Soap Solutions.



Curve II. Wetting Power to Woolly Aphis of Tar-Oil Emulsions.



Lissapol C, a sulphate of a long chain alcohol.
R.D.4173, a sulphonated fish oil.
A winter petroleum emulsion.
Paraffin emulsion.

As insect material was not available in large quantities only a few concentrations could be used and it was decided in the first place to use concentrations similar to the more generally used concentrations of soft soap taking 0·5 per cent. as the highest for most substances and 0·1 per cent. as a lower concentration. Information already available suggested the addition of Agral N and Agral II at 0·5 per cent. Emulsions were tested at higher concentrations. The results are shown in Table III.

Results.

Table III.

Per cent. Kill of Various Wetters Used Against Woolly Aphis.

Concentration.	0·05%	0·1%	0·5%	1·0%	2·0%	3·0%	5·0%
Agral I + Nicotine	—	8	16	—	—	—	—
Agral N + Nicotine	7	12	28	—	—	—	—
Agral II + Nicotine ..	5	15	75	—	—	—	—
R.D. 4117 + Nicotine ..	—	13*	17	—	—	—	—
R.D. 4117 alone	—	3	5	—	—	—	—
Sulphonated Lorol + Nicotine	—	12	22	—	—	—	—
Lissapol A + Nicotine ..	—	—	8	6	—	—	—
Lissapol C + Nicotine ..	—	—	30	36	—	—	—
R.D. 4173 + Nicotine ..	—	—	—	15	15	—	39
Soft Soap + Nicotine ..	—	1	10	77	96	97	—
Winter petroleum emulsion ..	—	—	—	70	71	94	100
Paraffin emulsion	—	—	—	0·4	25	59	83
Tar-Oil emulsion	—	—	—	—	3	—	16

* In this case the wetter was used at 0·25%.

These figures show that amongst those substances in which nicotine is the toxic agent and which are suitable for spring and summer use only one gave a kill sufficiently high to be of interest. Agral II at 0·5 per cent. with nicotine, gave a kill of 75 per cent. which was as good as soft soap at twice that concentration and Agral II would seem to be the only substance worth further trial. The phytocidal properties of the sample used (R.D. 4206/4281) are not known, but an earlier sample when used at 0·1 per cent. with lime-sulphur was found to cause serious cracking and russeting of fruit as will be reported elsewhere. If this preparation can be modified to remove the phytocidal effect without impairing wetting power and if a concentration of at least 0·5 per cent. is likely to be economic, it may be of use for Woolly Aphis control.

This method of testing of course only gives comparisons among a series of substances and does not express their action in the field since mechanical factors must then be considered. The amount of foliage present on the tree is important. When the tree is in full leaf, stem feeding insects such as Woolly Aphis are protected from the spray by the leaves. Also trees are as a rule only sprayed from two directions, often from only one in windy weather, so that many of the colonies of aphis are only reached by a few drops of the spray although the foliage may be thoroughly covered. This protection by the leaves probably partly explains the many failures to control Woolly Aphis with a summer petroleum emulsion when petroleums are such effective wetters in laboratory

tests. Winter and early spring control methods are to be preferred for Woolly Aphis. It is possible to obtain a complete kill with high concentrations of tar-oil in the laboratory and high concentrations may be equally good in the field.

It is hoped to devise a method of sampling in the field which will give an idea of the kill obtained there and so establish an approximate relationship between laboratory and field results.

Single Tree Sprayings in the Field.

In addition to the above laboratory tests the following substances were tested earlier in the year by spraying single small trees.

Lime-sulphur.
Lime-sulphur and nicotine.
Lime-sulphur and sulphite lye + nicotine.
R.D. 4173.
R.D. 4173 + nicotine.

None of these gave any considerable degree of control but a successful method of sampling was not arrived at so that no comparison could be made between them.

Tests of Wetting Power to the "Wool" Alone.

Approximately equal tufts of "wool" were floated on the solutions in watch glasses. The following solutions were used :—

Agral N	1%	
Agral I	1%	
Agral II	1%	0·1%
R.D. 4173	1%	
R.D. 4117	1%	
Lissapol A	1%	
Lissapol C	1%	
Sulphonated lorol	1%	
Soft Soap	1%	0·5%

Agral II had completely wetted the tuft of "wool" in forty minutes, while none of the others showed signs of wetting before one hour. Soap was the next best followed by Agral N and sulphonated lorol. Soft soap at 0·5 per cent. was very much better than Agral II at 0·1 per cent. None of these preparations had any apparent solvent action on the wax threads.

This method though admittedly somewhat crude, proved interesting from the fact that Agral II was so much better than the other preparations, a superiority which was also shown in the other trials.

Tests of Various Wetters and Insecticides Against Strawberry Tarsonemid Mite.

Strawberry Tarsonemid Mites live mainly in the young leaves in the middle of the plant away from daylight. Their feeding kills, or at least cripples, the young leaves before they can open. In order to kill the mites by spraying the liquid must penetrate between the tight folds of the young leaf which has a fringe of interlacing hairs.

The following wetters were tested on single plants in combination with 3 per cent. lime-sulphur.

Agral I	1%
Agral N	1%
Agral II	1%
R.D. 4117	1%
Lissapol A	1%
Lissapol	1%
Sulphonated lorol	1%
Soft Soap	1% (without lime-sulphur)
R.D. 4173	1% " " "

None of these gave any kill even of the young nymphs which are the most susceptible to insecticides and in most cases the inside of the folded leaf remained dry.

Later the following substances applied with a knapsack machine were tried on rows of about a dozen plants each.

Lime-sulphur	1 to 5% and 14%
Petroleum emulsion	2% and 5%
Paraffin emulsion	2%, 5%, 10%, 50% (possibly not properly emulsified)
Liver of sulphur (30 ozs.) and soft soap	10 lbs. and 20 lbs. per 100 gallons

The results were judged by eye as any other method was considered unnecessary until a reasonable kill could be achieved.

Liver of sulphur with 20 lbs. of soap per 100 gallons gave a very slight kill but none of the others penetrated the folded leaf. Lime-sulphur at 14 per cent., petroleum emulsion (winter grade) and paraffin emulsion 50 per cent. caused serious damage, the last almost destroying the plants, but even after this there were mites present in large numbers and no evidence of kill could be found.

The writer is indebted to Mr. T. N. Hoblyn for the statistical examination of some of the results.

Summary.

A laboratory method of testing the wetting power of a substance to Woolly Aphis was devised.

This method gives an accurate comparison between substances though the relation to field results is not yet known.

A number of wetting preparations were tested by this method and the results are tabulated. Only one preparation suitable for summer use gave sufficiently good results but the concentration used was above the suggested limits and in its present form it is known to be phytocidal even within those limits.

None of the substances tested had any solvent action on the wax of woolly aphis though one possessed outstanding wetting power when tested against the wax alone.

Preliminary trials against Strawberry Tarsonemid Mite are mentioned.

INSECTICIDES AND FUNGICIDES

STUDIES ON *BYTURUS TOMENTOSUS* FABR.

V. 1934 EXPERIMENTS ON THE CONTROL OF THE RASPBERRY AND LOGANBERRY BEETLE

By W. STEER

THREE field trials were carried out in 1934. They comprised :

1. A dusting trial on raspberries,
2. A spraying trial on Himalaya Berry, and
3. A combined Cane Spot and Beetle spraying trial on loganberries.

Derris root, which was the only insecticide used in these trials, was purchased in bulk, in a finely ground form, from a large firm of insecticide manufacturers. Samples submitted to Dr. Tattersfield were found to contain 3·63 per cent. crude, or 2·92 per cent. re-crystallized rotenone. As a spray it was used at the rate of 2 lbs. per 100 gallons. For use as a dust it was mixed with china clay in an electrically driven mixing machine.

The sprays were all applied by means of a Cascade, hand-pump machine supplying a single nozzle at a pressure of about 200 lbs. For the dusts a small rotary hand duster was used.

The sampling method which was employed to obtain the data on fruit infestation has been fully described in earlier communications (2, 3).

1. RASPBERRIES—DUSTING TRIAL.

An unsuccessful attempt to control the adult stage of this pest, by means of a single application of a Derris dust was described in last year's report (4). The results did not agree with those of Petherbridge and Thomas (1) who in 1932 dusted loganberries in a similar manner.

It was thought desirable to repeat the 1933 experiment on a larger scale, using heavier applications and a dust of higher rotenone content.

For this trial there were available twelve long rows (about $\frac{1}{3}$ acre in all) of Lloyd George raspberries. The central four rows were left undusted to serve as a " buffer ". The remaining eight rows were divided into eight plots, each containing four rows about 36 yards in length. The treatments were randomized and duplicated.

Dusting was carried out (in the early morning) on 27th-28th May, each of the dusted plots receiving one application only. The treatments were as follows :

A. Undusted (control).
B. Heavy application, 10% dust.
C. Light application, 10% dust.
D. Heavy application, 5% dust.

Approximately 3 cwt. of dust per acre were used on the heavily dusted and 1 cwt. on the lightly dusted plots. Portions of the buffer rows were subsequently (21st June)

sprayed with Derris and soap to serve as a standard of comparison in estimating the value of the dusts.

Results.—The results are shown in Table I.

TABLE I.

Treatment.	Per cent. Infested Berries.	Per cent. Reduction.
A. Control (undusted)	43·6	—
B. Heavy— 10 per cent.	24·2	44·5
C. Light— 10 per cent.	31·1	28·7
D. Heavy— 5 per cent.	25·7	40·9
Derris and soap	2·8	92·8
Control	38·8	—

None of the dusting treatments gave entirely satisfactory results.

This suggests that more than one application of a Derris dust is necessary to control the adult stage of the pest, whereas a single spraying of Derris and Soap gives an adequate control of the larvae.

2. LOGANBERRIES—SPRAYING TRIAL.

The main object of this trial which was carried out in collaboration with the Mycology Section, was to determine to what extent Loganberry Cane Spot (*Elsinoë veneta*) can be controlled by the inclusion of a fungicide in the late June " beetle spray ".

The spray treatments were as follows:

1. Derris and soap.
2. Derris, lime-sulphur and sulphite lye.
3. Derris, " colloidal copper " and sulphite lye.

Derris was used at 2 lbs., lime-sulphur at 2 gallons, the " colloidal copper "* at 2 pints, and the sulphite lye at 6 pints, per 100 gallons.

Four rows of loganberries were used in this trial. These were divided into twenty plots of three bushes each, six plots to each of the spray treatments and two plots left unsprayed to serve as a check on the performance of the Derris and soap.

The sprays were applied on 22nd June. Derris and soap wet much better than either of the other sprays, although these were with heavy spraying, made to wet the berries reasonably well.

The results are shown in Table II.

TABLE II.

Treatment.	Per cent. Infested Berries.
Derris + soap	5·3
Derris + lime-sulphur + sulphite lye	9·4
Derris + " colloidal copper " + sulphite lye ..	5·2
Unsprayed	45·9

* The " colloidal copper " spray fluid used in this experiment is based on copper oxychloride and was used in preference to Bordeaux as being less likely to leave an objectionable deposit on the berries. Sulphite lye was used as a wetter since it was a constituent, apparently, of this copper spray fluid.

It is clear that, from a commercial point of view at any rate, Derris controlled the larval stage of the pest satisfactorily, whether applied in the normal manner, with soap as a wetter, or as an ingredient of a mixed wash. Actually the spray containing lime-sulphur appears to have been slightly less efficient than either of the others.

Although an appreciable control of the Cane Spot disease was obtained by these combined washes the work on this aspect of the work is not sufficiently advanced to warrant a detailed report. Moreover the nature and extent of the residues which mixed washes may leave on the berries, and which are of great importance to the canners, will have to be studied before any mixed wash for combined Cane Spot and Beetle control can safely be recommended. This trial serves merely to demonstrate the ability of such a wash to control the Beetle.

3. Blackberries—Spraying Trial.

Evidence was obtained in 1933 (4) which suggested that Raspberry Beetle could be adequately controlled on cultivated blackberries by means of a single application of Derris and soap. Confirmation of this was sought, therefore, during the past season.

A small scale spraying trial was carried out on twelve plants of the Himalaya Berry, arranged in four blocks of three bushes each so that one out of every three bushes was left unsprayed as a " control ".

Derris and soap was applied on 12th July after a few larvae had begun to attack the earlier berries.

The results are shown in Table III.

Table III.

Treatment.	Per cent. Infested Berries.	Per cent. Reduction.
Sprayed	2·6	88
" Control "	22·0	—

Although the attack was not particularly severe, this trial serves to confirm the results obtained with a single spraying in 1933, when the attack was reduced from 55·4 to 4·5 per cent.

Summary.

A single application of a Derris dust, applied late in May to control the adult stage of the Raspberry and Loganberry Beetle failed to give satisfactory results on raspberries, even when the rate of dusting was about 3 cwt. per acre and the (crude) rotenone content of the dust as high as 0·36 per cent.

On loganberries Derris gave as good results when incorporated in a spray of lime-sulphur and sulphite lye or of " colloidal copper " and sulphite lye as when used with soft soap.

A small scale trial on Himalaya Berry confirmed last season's finding that a single application of Derris and soap can satisfactorily control the pest on cultivated blackberries.

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(2) Steer, W. Journ. Pom. and Hort. Sci., 1932, **10,** 1-16.

(3) ——— Journ. Pom. and Hort. Sci., 1933, **11,** 19-38.

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FIELD SPRAYING AND DUSTING TRIALS ON THE CONTROL OF APPLE BLOSSOM WEEVIL AND OF APPLE SAWFLY IN 1934

By W. STEER and F. J. D. THOMAS

I. APPLE BLOSSOM WEEVIL (*Anthonomus pomorum* L.).

Dusting Trials.

Experiments carried out in 1933 (2) showed that blossom "capping" could be lessened by applying a Derris dust at the beginning of the weevil's egg laying period. Several experiments were carried out in 1934 in order to confirm the 1933 results, to obtain critical information as to the proper timing of a Derris dust, and to test the value of a barium silicofluoride dust.

Most of the trials were, unfortunately, spoilt by rain. The only trial not so affected was carried out at a late date (26th April). The application of the dusts was too late to prevent a good deal of egg laying (which actually began, according to our records, on 16th April), but was considered early enough to inhibit the deposition of the later laid eggs.

The Derris dust was composed of 10 per cent. finely ground Derris root and 90 per cent. china clay. An analysis supplied by Dr. Tattersfield, of the Rothamsted Department of Insecticides, showed that the sample of Derris used contained 3·63 per cent. (crude) rotenone. The 10 per cent. dust would, therefore, have a very high rotenone content (0·36 per cent.).

The barium silicofluoride dust was a proprietary preparation stated to contain 72 per cent. barium silicofluoride, 8 per cent. sodium fluoaluminate and 20 per cent. inert material.

The dusts were applied by means of a small rotary hand machine to two rows of cordons (variety Cox's Orange Pippin), and dusted, "buffer" and "control" portions, were alternated down the rows.

Random sample counts of capped and uncapped blossoms were made towards the end of May, with the result shown in Table I.

Table I.

Treatment.	Number of Blossoms Counted.	Per cent. capped by Weevil.
Derris dust	2,600	8·5
"Control"	3,500	19·5
Barium dust	1,200	14·2
"Control"	2,400	16·1

The Derris dust (although applied at a late date) reduced the amount of "capping" by half, but the barium preparation appears to have had no effect at all. This is not surprising since, as Miles has shown (8), the weevils reject the surface tissues and feed on the mesophyll and are thus unlikely to be affected by a deposit of a stomach poison (such as the barium preparation used in this trial).

Spraying Trial.

The realization, as a result of experiments carried out in 1933 (3), that the eggs of Apple Sawfly are vulnerable to nicotine *at any stage of their incubation period* suggested that the eggs of Apple Blossom Weevil might also prove vulnerable.

A small trial was accordingly carried out on a few Cox cordons and the trusses were thoroughly sprayed with nicotine and Agral I. A high concentration of Agral I ($2\frac{1}{2}$ lbs. per 100 gallons) was used in the hope of facilitating penetration (since the weevil eggs are laid in unopened buds). On one series of trees the nicotine was used at 8 ozs. and in a second series at 10 ozs. per 100 gallons.

Spraying was carried out by means of a knapsack machine on 25th April (the earliest date on which a newly hatched larva was found). A later spraying also was contemplated but was not carried out on account of a certain amount of scorching which the spray apparently caused.

The results of random sample counts are shown in Table II.

Table II.

Treatment.	Number of Blossoms Counted.	Per cent. Capped.
Controls (unsprayed)	2,000	19·8
Nicotine (0·05%) + Agral I (0·25%)	1,000	13·1
Controls	2,000	22·3
Nicotine (0·06%) + Agral I (0·25%)	1,000	14·3

It is extremely doubtful whether the nicotine in any way affected the eggs.

Conclusions.

The weather conditions which prevail during the "green-bud" stage and the length of the weevil's egg-laying period are serious obstacles to the degree of control which can be obtained by dusting. Despite this, Derris dusts have, in two consecutive seasons' trials, given promising results, but, to obtain a satisfactory measure of control, it would probably be necessary to give several applications and to renew the dust deposit whenever it is washed off by rain.

II. APPLE SAWFLY (*Hoplocampa testudinea* Klug.).

Introductory.

Many of the 1934 trials were tests of various forms and concentrations of wetters for use with a petal-fall spray of lime-sulphur and nicotine. Confirmation of the previous season's results (3, 4) was also sought with regard to the ovicidal value of nicotine, the relative merits of Derris, nicotine and lead arsenate as ingredients of a petal-fall spray, and the value of Derris as a means of inhibiting secondary attack by migrating larvae.

Spray Materials.

Lime-sulphur and nicotine were used at standard rates of 6 pints and 8 ozs. respectively per 100 gallons. The concentrations of the other ingredients used are indicated where necessary (as amounts used per 100 gallons) in appropriate positions in the tables of results.

The Derris and the barium silicofluoride preparation used in certain of the trials have already been described in connection with the Apple Blossom Weevil experiments. For use as a dust the Derris was mixed with China Clay in the proportions of 1 : 9 ; as a wet spray it was used at a dilution of 2 lbs. per 100 gallons.

Three different wetters were tested : Agral N, Agral I and Sulphonated Lorol.

Agral N is a sulphonate of an alkylated cyclic hydrocarbon.

Agral I is a diluted form of Agral N.

Sulphonated Lorol is mainly the sodium salt of sulphated lauryl alcohol. There are now on the market several proprietary materials containing this wetter as a major constituent.

Spraying Technique.

A coarse, driving spray was used throughout with the object of thoroughly wetting the calyx cup.

The term " petal-fall " is here taken to mean when about 80 per cent. of the petals have fallen and when most of the remainder fall readily when the tree is shaken slightly. The term " wetter " is used in the broad sense of " wetter and spreader ".

Recording of Results.

In each trial complete records were kept of the " drops ", windfalls and picked crop in the manner described in a previous report (3).

The " per cent. attack " shown in the tables was arrived at by reckoning the total number of sawfly damaged apples (drops and crop together) as a percentage of the " total set ", the total set being simply the total of drops and picked fruits.

THE 1934 FIELD TRIALS.

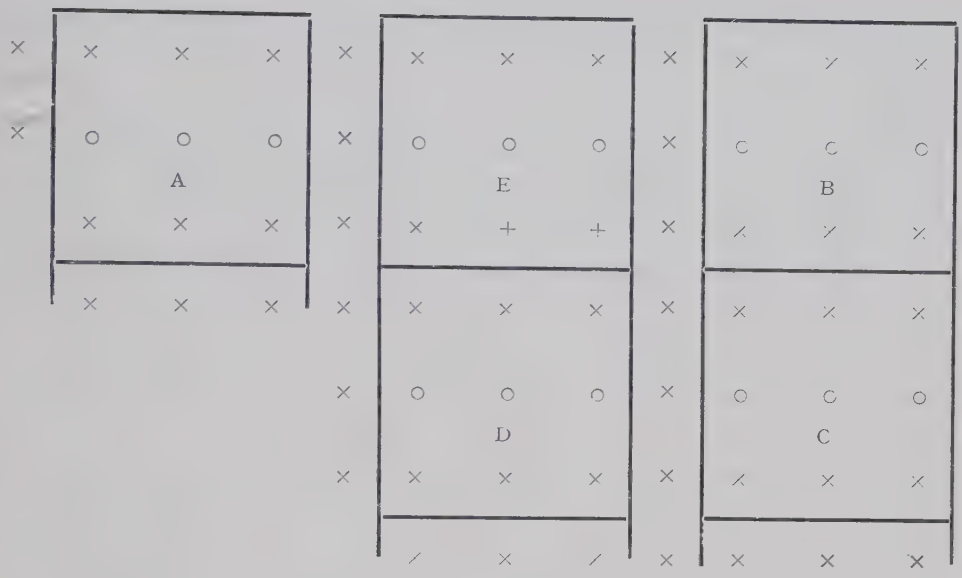
Comparison of Various Wetters.

A trial was carried out on Worcester Pearmain to ascertain the comparative values of three different wetters (Agral N, Agral I and Sulphonated Lorol) for use in a petal-fall spray of lime-sulphur and nicotine. Comparison was also made with the proprietary combination of Agral N and nicotine known as Nictagral C. The latter spray was used at a dilution sufficient to ensure that the spray applied contained 8 ozs. of nicotine per 100 gallons.

Layout. The plantation was divided into twenty plots, arranged in four blocks of five, and the treatments were arranged at random within each block. Each plot contained nine trees, but of these only the three centre ones were used for record purposes, the layout being such that these three indicator trees were in all cases protected by guard rows from neighbouring treatments.

The plan of one of the four blocks is shown in Fig. 1, where the circles represent " indicator " trees and the letters A, B, C, D, E the five treatments.

FIG. 1.



Observations. The trees were in full bloom on 11th-12th May, and at "petal-fall" on 21st-23rd May.

Oviposition began on 8th May and *continued till well after spraying.*

The sprays were all applied on the morning of 23rd May and the first hatching was observed on 27th May.

TABLE III.

Treatment.	% Attack.
Lime-sulphur + Sulphonated Lorol (1 lb.)	39·4
L.S. + Nicotine + Sulphonated Lorol (1 lb.)	16·5
L.S. + Nicotine + Agral I (1 lb.)	16·3
L.S. + Nicotine + Agral N ($\frac{1}{2}$ lb.)	16·4
L.S. + Nictagral C (1 in 200)	13·8

Differences of less than 4·8 are not significant.

Results. These figures suggest that the three wetters were, at the concentrations used, of equal value.

Nictagral C was evidently quite as effective as nicotine and a wetter.

Each of the nicotine treatments reduced the attack considerably, but to a lesser extent than did either nicotine and soap on the same trees in 1933, or nicotine, lime-sulphur, and a wetter on other trees (Tables IV, V, VI, VII) in 1934. In this connection it should be noted that:

1. A good many petals were still on the trees at the time of spraying; these, contrary to expectation, did not turn brown but remained attractive to ovipositing adults for some days.

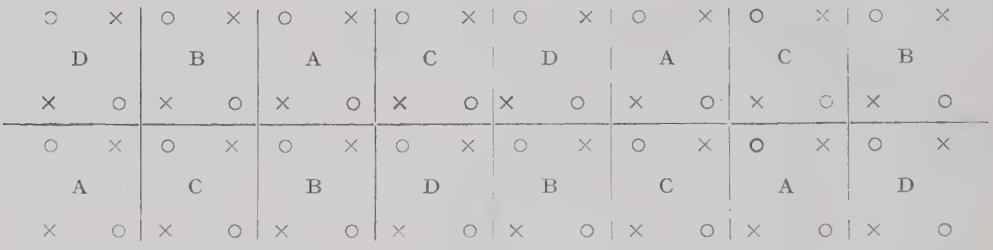
2. An unusual number of late blossoms appeared after the date of spraying, and were heavily attacked by late adults which flew in from a neighbouring plantation.

THE NECESSITY FOR A WETTER.

To obtain a satisfactory measure of control of sawfly by the addition of nicotine to the petal-fall scab spray apparently calls for heavy spraying. The addition of a wetter has been presumed to be necessary. Two trials were carried out partly with the object of ascertaining whether a wetter is essential to enable good results to be obtained with a heavy application of lime-sulphur and nicotine.

Layout. The type of layout adopted in each of these trials is shown in Fig. 2.

FIG. 2.



The crosses represent trees used in the experiment and the circles represent trees of another variety, used merely as " buffers ". A, B, C and D are four spray treatments. The sprays used are shown in Table IV.

Observations. In one trial (on James Grieve) the trees were in full bloom on 11th-12th May, and at the petal-fall stage by 17th May. In the other (on Worcester) the trees were in full bloom on 10th-11th May, and at petal-fall on 16th-17th May.

Oviposition began on 8th May and hatching was first observed on the Worcesters on 25th May and on the Grieves on 26th May.

The Worcesters were sprayed on 17th May—eight days before the beginning of hatching. The petal-fall sprays were applied to the Grieves on 18th May and the later spray on 25th May (all before the beginning of hatching).

Results. The results of the two trials are, for the sake of convenience, summarized in one table (Table IV).

TABLE IV.

Treatment.	% Attack. Worcester.	Grieve.
" Controls "—Lime-sulphur only	22·3	6·3
L.S. +Nicotine	3·8	1·2
L.S. +Nicotine +Sulphonated Lorol (½ lb.)	3·4	—
L.S. +Derris +Sulphonated Lorol (½ lb.)	8·8	—
L.S. +Nicotine +Agral I (1 lb.)	-	1·2
Ditto a week later	-	0·9

In either trial differences of less than 3·0 are not significant.

The figures suggest that the performance of a petal-fall spray of lime-sulphur and nicotine is not improved by the addition of a wetter. Although the wetting properties

of the lime-sulphur itself, applied, as it was, as a coarse, drenching spray, were apparently adequate to enable the nicotine to penetrate to the sawfly eggs, it is probable that the addition of a wetter, by facilitating rapid wetting and spreading, effects a saving both of spray material and of spraying time. Owing to the somewhat complicated layout, the arrangement of the spraying tackle and the variability in the size and accessibility of the trees, it was impossible, in these trials, to keep exact records of the amounts of spray used or of the time spent in spraying.

The results of the trial on James Grieve bear out the conclusion drawn from last season's trials that nicotine gives a high kill applied at any time between the petal-fall and the beginning of hatching. It should be pointed out, however, that the infestation in this trial was very low and conclusions drawn from the results must, therefore, be accepted with reserve.

On the Worcesters, nicotine, lime-sulphur and a wetter reduced the attack by about 85 per cent., whereas Derris reduced it by only 60 per cent., a result which agrees well with last season's findings.

Concentration of Wetter.

In two small scale trials carried out on Worcester Pearmain, an attempt was made to determine the minimum effective concentration of wetter (Agral I) which would give satisfactory results.

In one trial spraying was carried out on 20th May by means of a " Cascade " hand-pump machine which supplied a single nozzle at a pressure of 200 lbs. Here, Agral I was used at 2 lbs., 1 lb., and $\frac{1}{2}$ lb. per 100 gallons with a standard concentration of nicotine. The great variation in intensity of sawfly attack, coupled with the fact that only three trees were used for each treatment, greatly detracts from the value of the results. These (Table V (*a*)) show no difference in performance between any of the spray treatments.

In the other trial, Agral I was applied on 25th May at 1 lb. and at $\frac{1}{2}$ lb. per 100 gallons, each with lime-sulphur and nicotine, by means of a small power machine, which supplied two nozzles at approximately 300 lb. pressure. The results (Table V (*b*)) of this trial are more reliable, owing to the larger number of trees used (six per treatment), but there is, again, no significant difference between any of the spray treatments.

The sprays were all applied before the beginning of hatching. During spraying, 1 lb. of Agral I appeared substantially as efficient as 2 lbs. per 100 gallons) but the wetting of the lowest concentration ($\frac{1}{2}$ lb. per 100 gallons) was visibly poorer.

Table V.

Treatment.	% Attack. (*a*) Hand pump.	% Attack. (*b*) Power machine.
Unsprayed " controls "	15·7	24·2
Agral I (2 lbs.) + Nicotine	4·7	—
Agral I (1 lb.) + Nicotine	8·4	—
Agral I ($\frac{1}{2}$ lb.) + Nicotine	3·4	—
Agral I (1 lb.) + Nicotine + Lime-sulphur	—	9·3
Agral I ($\frac{1}{2}$ lb.) + Nicotine + Lime-sulphur	—	9·9

In (*b*) differences of less than 5·5 are without significance.
In (*a*), although no analyses were made, the results are obviously without significance.

The Value of a Lime-Sulphur—Lead Arsenate Spray.

Earlier work has shown that lead arsenate, applied at petal-fall does not control Sawfly except, possibly, in combination with a fungicide. Thus Petherbridge and Tunnington (10), Moore (9) and Hey and Steer (3) all failed materially to reduce sawfly by means of petal-fall applications of lead arsenate. An appreciable reduction was, however, stated by Grubb and Bagenal (1) and by Moore (*loc. cit.*) to be caused by a mixture of lime-sulphur and lead arsenate.

The suggestion has been put forward by Moore (*loc. cit.*) that a petal-fall combination spray of lead arsenate with either lime-sulphur or Bordeaux mixture exerts a toxic action on the sawfly egg. It was to gain further information on this point that a trial was carried out, on thirty trees of the variety Annie Elizabeth, in which lime-sulphur, lead arsenate and a mixture of lead arsenate and lime-sulphur were tested side by side. Comparison was also made with a spray of lime-sulphur, nicotine and Agral I.

Layout. The layout adopted was similar to that shown in Fig. 2.

Observations. The trees were in full bloom on 13th May and at petal-fall by 21st-22nd May. Hatching was first observed on 30th May. The sprays were all applied on 23rd May, a week before the beginning of hatching.

Table VI.

Treatment.	% Attack.
Lime-sulphur (6 pints)	26·5
Lead arsenate (4 lbs.)	21·0
Lime-sulphur + Lead arsenate	21·7
Lime-sulphur + Nicotine + Agral I (1 lb.)	7·9

Results. It is clear from Table VI that a mixture of lime-sulphur and lead arsenate was no better than lead arsenate alone. Little, if any, reduction in the attack was brought about by either spray by comparison with lime-sulphur alone. The figures do not support the results obtained by Grubb and Bagenal and by Moore.

Nicotine again gave good results and provided additional evidence of the susceptibility of the sawfly eggs to nicotine.

The Value of Derris in the Petal-fall Scab Spray.

In 1933 Derris, used at petal-fall, was inferior to nicotine but gave an appreciable measure of control except in one trial carried out on James Grieve. A special trial was, therefore, carried out on James Grieve in 1934 to see whether this anomalous result would be repeated and to compare further Derris and nicotine as ingredients of the petal-fall spray. Derris was also included in one of the trials carried out on Worcester Pearmain (Table IV).

Layout. This is shown in Fig. 2.

Observations. The trees were in full bloom on 11th-12th May and at petal-fall on 18th May, at which date the petal-fall sprays were applied. The later spray was applied on 25th May, just before the beginning of hatching. Hatching was first observed on 27th May but probably began on 26th May.

TABLE VII.

Treatment.	% Attack.
Lime-sulphur + Sulphonated Lorol (½ lb.)	21·8
L.S. + Suphonated Lorol + Nicotine	4·3
L.S. + Sulphonated Lorol + Derris	10·8
Ditto, a week later	8·6

Results. Derris reduced the attack considerably, whether applied at petal-fall or a week later. Nicotine, applied at petal-fall, was apparently superior to either of the Derris applications though this could not be confirmed by statistical examination. The failure to reduce the attack with Derris and lime-sulphur on Grieves in 1933 was evidently, as suggested in last year's report, due to the heavy rain which fell soon after spraying. On Worcester (Table IV) Derris reduced the attack by 60 per cent., and the results of the two trials agree well with those of 1933.

THE PREVENTION OF SECONDARY ATTACK.

The importance of the secondary phase of sawfly damage, caused by migratory larvae, has been noted in previous reports (7, 3, 4) and it has been shown (3, 4) that secondary attack can largely be inhibited by the use of a Derris dust.

To obtain confirmation of the results obtained with Derris in 1933 and to ascertain the potentialities of a barium silicofluoride dust, a trial was carried out on ten trees of the variety White Transparent.

Layout. Individual trees, chosen at random, were thoroughly dusted by means of a two-wheeled, hand-operated machine.

Observations. Migrating larvae and secondary attack on the fruitlets were first observed on 4th June. The dusts were applied on 8th June—the earliest opportunity which occurred after 4th June.

When the records were taken, scarred fruits were counted as primary, and holed fruits as secondary infections.

Results. In Table VIII the figures in the " total set " column represent the sum of the drops and picked fruits. The numbers of scarred and holed fruits are expressed as percentages of the total set and are then on a common basis for purposes of comparison. Then by expressing the secondary as a percentage of the primary attack, a measure is obtained of the increase in sawfly attack brought about by migrating larvae.

TABLE VIII.

Treatment.	Total set.	% Primary.	% Secondary.	Secondary as % of primary.	% Reduction in secondary attack.
Undusted " controls " (4 trees)	8,591	4·6	5·4	111·7	—
Derris dusted (4 trees)	9,265	5·0	1·4	28·0	76·1
Barium dusted (2 trees)	4,061	3·7	2·4	64·9	44·7

It will be seen that each of the dusts affected the migrating larvae and so prevented a great deal of damage. Derris, which probably acts largely, if not entirely, as a contact insecticide, gave better results than barium silicofluoride, which, presumably, acts only as a stomach poison.

Conclusions.

Nicotine. There is little doubt (in view of the results of the experiments carried out here during the past two seasons) that nicotine gives the best results when applied before the beginning of hatching, since it is highly toxic to the eggs of sawfly. In most of our experiments, a single (petal-fall) application proved adequate and reduced the infestation by about 80 per cent. The results of one of our trials, however, in which nicotine (with lime-sulphur and a wetter) reduced the damage by only 60 per cent. (Table III), suggest that a single spraying is sometimes insufficient. In such (apparently exceptional) cases, two sprayings may, as Kearns suggests (5), be advisable, the first at petal-fall and the second a week later.

Wetters. It has been conclusively established at East Malling and at Long Ashton (6) that nicotine can be added to the lime-sulphur scab spray without consequent loss of insecticidal properties. Provided such a wash is applied liberally and with considerable force, adequate wetting of the eye and sides of the fruitlets—and, consequently, a good control of sawfly—can be obtained without the addition of a " wetter ". It is probable, however, that the presence of a " wetter ", by accelerating wetting and spreading, effects a saving of both time and spray materials and is, therefore, to be recommended.

Of the three wetters tested in 1934, Agral I was successfully used at 1 lb. and Agral N and Sulphonated Lorol at $\frac{1}{2}$ lb. per 100 gallons.

Lead Arsenate. It would seem from our experiments that the inclusion of lead arsenate in a petal-fall spray is not warranted. Kearns, Marsh and Swarbrick (6) have shown that if the lime-sulphur nicotine spray is applied a week after petal-fall, after a good deal of hatching has taken place, then the addition of lead arsenate results in a measurable increase in sawfly control. That lead arsenate is more effective applied a week after petal-fall than at petal-fall proper was shown by Hey and Steer (3). The amount of control obtainable by lead arsenate does not, under our conditions, justify its use for sawfly, either alone or as an ingredient of the petal-fall spray.

Derris. In 1934, as in 1933, nicotine proved superior to Derris as an ingredient of the petal-fall scab spray. It has been shown (3) that nicotine is less effective if spraying is delayed till the beginning of hatching and is then no better than Derris. Although Derris cannot be recommended for sawfly control in preference to nicotine, it is more effective than lead arsenate.

The application of a Derris dust when the larvae begin to migrate (usually ten to fifteen days after petal-fall) prevents most of the secondary phase of sawfly damage. As a practical measure of control, however, this method is applicable only in cases where the petal-fall spray has been omitted or has, by reason of poor spraying or late timing, given indifferent results.

Acknowledgments.

We are indebted to Mr. H. B. Weston, of Rocks Farm, East Malling, for the use of his orchard and for facilities for carrying out some of the trials ; to Dr. F. Tattersfield, of the Rothamsted Department of Insecticides, for analyses of the Derris root used ; and to Mr. T. N. Hoblyn for assistance in plot planning and for help with the statistical

analyses of the results. Grateful thanks are also due to several members of the Staff (particularly Messrs. Amos, Moore and Painter) who permitted a great deal of disturbance of the routine operations of spraying, picking and marketing to meet the special requirements of these experiments.

The work was carried out partly with the aid of a grant from Imperial Chemical Industries Ltd., and partly with the aid of funds provided for Derris research by the Kent Branch of the National Farmers' Union, Messrs. Cooper, McDougall & Robertson, Ltd., and various private individuals.

Summary.

Blossom capping, due to Apple Blossom Weevil (*Anthonomus pomorum* L.) was reduced by about 50 per cent. by a Derris dust (rotenone content 0·36 per cent.) applied to prevent oviposition, whereas a barium silicofluoride dust was ineffective. An attempt to kill the eggs with nicotine was unsuccessful.

The trials carried out against Apple Sawfly (*Hoplocampa testudinea* Klug.) confirmed last season's findings :

1. That the eggs are very susceptible to nicotine and that the addition of nicotine to the petal-fall, lime-sulphur scab spray gives a good control.
2. That Derris can considerably reduce sawfly damage but is inferior to a *petal-fall* application of nicotine.
3. That a Derris dust can control the migratory larvae and so prevent most of the secondary damage.

The experiments failed to show that the addition of a wetter to a petal-fall spray of lime-sulphur and nicotine is essential, provided the trees are very heavily sprayed, but reasons are given why the use of a wetter is probably advisable in commercial practice.

No support was obtained for the suggestion that lime-sulphur—lead arsenate is more effective than lead arsenate alone. As a petal-fall spray, lead arsenate, either alone or in combination with lime-sulphur was less effective than lime-sulphur and Derris (with a wetter).

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PRELIMINARY EXPERIMENTS ON THE CONTROL OF APPLE SURFACE-EATING TORTRICID LARVAE

By F. J. D. THOMAS

Apple surface-eating tortricids, considered as important pests in many parts of the country, are not satisfactorily controlled by the usual routine sprays. In 1933, Hey and Massee (1) determined the principal species of tortricids responsible, and concluded that *Cacoecia podana* Scop. was, in that year, by far the most important of these. An account of the life history of this species has since been published by Hey and Thomas (2). In 1934, preliminary experiments on tortrix control, based on these studies, were undertaken.

Two trials were carried out, but in the first of these the amount of tortrix present proved negligible and the results were consequently of no value. In the second trial, a reduction of some 50 per cent. in the attack on the fruit was obtained.

Dusting Trial.

The object of this trial was to apply a protective dust to the fruit before tortrix attack began. Moths of both Codlin and *Cacoecia podana* Scop. were beaten from the trees (Worcester Pearmain) available for this trial during the latter part of June. On the 17th July two dusts were applied, one Derris and the other barium silicofluoride. Subsequent observations and counts on both windfalls and crop showed very little tortrix damage to the fruit on any of the trees, including the undusted controls. Such surface damage as occurred was mainly due to very young Codlin larvae and not to *Cacoecia podana* Scop. Some of this surface damage caused by young Codlin larvae could possibly be confused with some types of damage due to *Cacoecia podana* Scop., hence the markings were examined in some detail and will be described at a later date.

Spraying Trial.

The second trial was carried out on a block of thirty-one trees of the variety James Grieve. The object here was to apply a spray-coating as soon as the first signs of attack were noted. It was thought that an application of Derris then would kill some larvae by direct contact, and some by subsequent contact when they crawled on the fruit to attack it. It was further thought that a coating of barium silicofluoride on the fruit might act as a stomach poison. Arsenicals should not be applied at so late a date owing to the danger of a deposit remaining on the fruit at picking time. Petal-fall on these trees was about the 17th May, and the beginning of attack on the fruit was not observed until shortly before the 26th July, when the sprays were applied. These were :

(1) Derris at 2 lbs. with soft soap at 5 lbs. per 100 gallons.

(2) A barium silicofluoride preparation at 4 lbs. with Agral N at 1 lb. per 100 gallons.

A 1½ h.p. machine supplying two nozzles at approximately 300 lbs. pressure was used for application of the sprays, which was made under favourable weather conditions. Twelve trees were sprayed with barium silicofluoride, eleven with Derris, and eight were left unsprayed as controls. The treatments were randomized throughout the block.

Samples of Derris used were submitted to Dr. F. Tattersfield of the Rothamsted Department of Insecticides and Fungicides, and proved to have a (crude) rotenone content of 3·63 per cent. Thus, at the dilution used, the spray had a (crude) rotenone content of 0·007 per cent. The barium silicofluoride preparation used contained 72 per cent. barium silicofluoride, 8 per cent. sodium fluoaluminate, and 20 per cent. talc.

In this trial the larvae attacking the fruit proved to be mainly those of *Cacoecia podana* Scop. By the third week in August the attack on the fruit was well advanced, and well marked signs of surface feeding were noticeable, mainly beneath leaves webbed to the fruit, and especially on the controls. Counts were made of the entire crop, including windfalls. The crop was picked during the period between the 29th August and the 10th September. The results are summarized in the Table.

TABLE.

TORTRIX CONTROL: EFFECT OF DERRIS AND BARIUM SILICOFLUORIDE SPRAYS.

Treatment.	No. of Trees.	Total No. of Fruits Examined.	Mean % Tortrix marked.	% Reduction.
"Control" unsprayed	8	6,779	9·15	—
Barium silicofluoride + Agral N. ..	12	13,018	5·95	35·0
Derris and soap	11	9,636	4·35	52·4

CONCLUSIONS.

From these figures, the Derris spray appears to have reduced the attack by about one-half, and the barium silicofluoride spray by about one-third. Statistical examination of the detailed records shows that the difference between the figures for mean per cent. tortrix marked for each of these spray treatments and that for the unsprayed trees is significant. Owing to the variability in material, the significance of the difference in control shown by the two sprays is doubtful, though the Derris would appear to show the greater promise.

Further information is needed regarding the best time or times of application, and on the relative merits of dusting and spraying for this pest.

The work described in this paper is in part a continuation of a study of the insecticidal value of Derris on which W. Steer (with whom the present writer was closely associated in the majority of this season's trials) has been engaged for some years with the aid of a grant from Messrs. Cooper, McDougall & Robertson, Ltd. It was further facilitated by a grant to this Station from Imperial Chemical Industries, Ltd.

Thanks are due to Dr. F. Tattersfield, whose analyses determined the concentration at which the Derris was used, and to Mr. T. N. Hoblyn who gave great assistance with the statistical analysis of the results.

Summary.

In a preliminary field trial, a 50 per cent. reduction of the damage caused by apple surface-eating tortricids (mainly *Cacoecia podana* Scop.) was obtained by an application of Derris and soap approximately nine weeks after petal-fall. Barium silicofluoride was rather less effective.

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A FIELD SPRAYING TRIAL OF COMBINED FUNGICIDE-CONTACT-INSECTICIDE SPRAYS IN 1934

A PROGRESS REPORT

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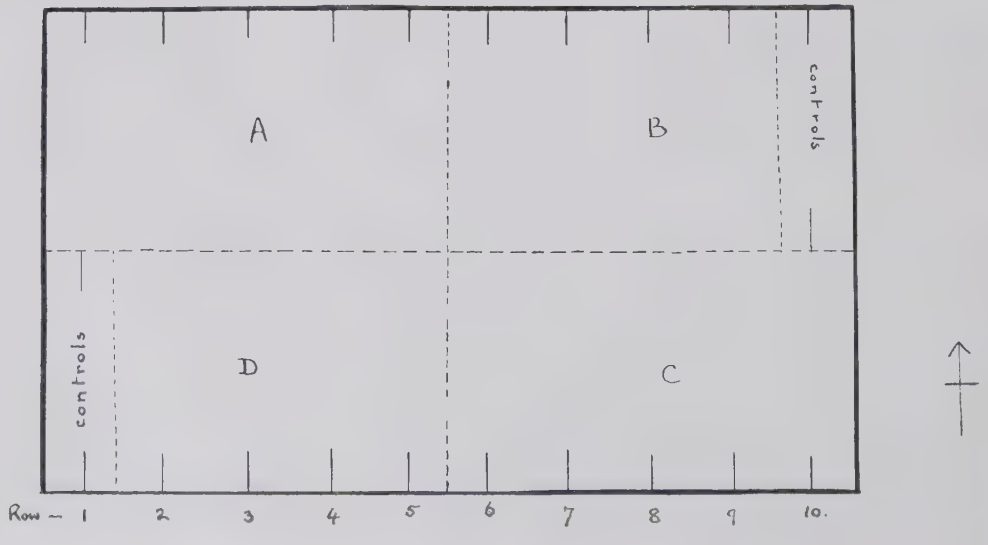
Introductory.

The present paper deals with the results of one year's work along the same lines as that described in the last Annual Report (4) which dealt with the 1933 experiments. There it was stated that " It is intended to use this plot (of Cox's Orange Pippin trees) for a few years to determine the best complete commercial spray-programme for this important dessert variety. This scheme will probably entail changing the programme of sprays every year to meet new problems as they arise."

The investigation is based on the use of combined sprays applied according to modern standards of spraying (which approximate more nearly to " washing ") by the ordinary farm spraying team. The value of each complete series of treatments is judged according to its fungicidal, insecticidal and acaricidal properties, for good control of pests and diseases must be attained with a minimum of spray-treatment. Spray-auxiliaries such as spreaders or stickers are used at certain periods to improve the " performance " of the basic specifics of which the spray is compounded, and it is for a comparison of the spreaders used that the 1934 trials here described have their chief purpose.

Description of Experiments.

The whole plot of 158 fourteen-year-old bush Cox trees supporting normal growth, and planted at 12 ft. apart in rows 24 ft. apart, was divided into four sub-plots, A, B, C, D, thus :



The rows, ten in number, run North and South, and there are sixteen trees in each row. The trees are worked respectively on eleven different layered rootstocks, and the stock-scion combinations are planted alternately in the rows so that the East half of the plot is a duplicate of the West half, and so that each of the four plots contains similar trees for comparison, except where rows 1 and 10 are concerned. In these rows, two stocks do not occur alternately in the complete row, and therefore there are no trees on No. VI in B or D and none on No. IV or No. XV in A or C. Four trees on each of No. IV and No. XV were left as unsprayed controls in the outside rows in each of B and D respectively. All the rest received spray treatment.

In 1933, the whole plot was divided North and South only, into two halves (trees on Stock No. VI being left as unsprayed controls) and, while the fungicide (lime-sulphur) and the spreader (sulphite lye) was constant in each half, the contact insecticide was different, Derris being compared with Nicotine. The latter proved to be much the more effective against Sawfly. Two pre-blossom applications of lime-sulphur were compared with one, and, in that year, no significant difference between them in Scab-control was shown.

In 1934, Derris was omitted, and each of the four plots received a standard fungicide (lime-sulphur) and insecticide (nicotine) while the spreader was varied. Two pre-blossom applications of lime-sulphur were again compared with one.

In detail, the treatments were :

Period.	Treatment. A	B	C	D
Green-bud	LS.A.	——	A.	——
Pink-bud	LS.A	LS.A.	LS.A.	LS.A.
Petal-fall	LS.N.S. lye.	LS.N.Leth.	LS.N.S. lye.	LS.N.S. lorol.
Three weeks after petal-fall	LS.N.G.	LS.N.G.	LS.N.G.	LS.N.G.

LS.	*Lime-sulphur :*	1-30 pre-blossom, 1-100 post-blossom.
A.	*Lead arsenate paste :*	4 lbs. per 100 galls. pre-blossom.
N.	*Nicotine :*	8 ozs. per 100 galls. at petal-fall (for Sawfly). 6 ozs. per 100 galls. at " three weeks " (for Aphis).
G.	*Spray-gelatine :*	1 lb. per 100 galls. Used as sticker to help in control as Red Spider. Dissolved in hot water before dilution in the spray.
Spreaders.		
S. lye	*Sulphite lye :*	6 pints per 100 galls., at petal-fall. Thinned down with water in a bucket before being transferred to the spray-tank.
S. lorol.	*Sulphonated lorol :*	1 lb. per 100 galls., at petal-fall.
Leth.	*" Lethalate " Standard Wetting Preparation "* :*	½ lb. per 100 galls., at petal-fall.

The trial differs fundamentally from that carried out in 1933 in that lead arsenate was used pre-blossom as a stomach poison (arsenate was not used pre- or post-blossom in 1933) and in that the normal strength lime-sulphur was used pre- (1-30) and post-blossom (1-100). In 1933, the pre-blossom strength was reduced to 1-40, and that at

* This preparation is a proprietary one which was tested solely in the interests of the experiments. It is of known composition guaranteed constant by the makers.

post-blossom to 6 pints per 100 galls. because of the risk of severe injury from the more heavily-applied sprays containing a spreader (sulphite lye).

Application of Sprays.

Spraying was done by the method normally used for the routine applications on the Research Station farm. For the green-bud and three-weeks sprays, a 10 h.p. portable plant was used, but at pink-bud and petal-fall this machine was not available, so a $2\frac{1}{2}$ h.p. outfit was employed.

Green-bud spray. Applied on 20th April, A and C only being sprayed. The delivery pressure was about 300 lbs. per sq. in., and two men sprayed, each using 4 ft. lances and double nozzles fitted with No. 0 discs. These delivered a fairly straight, driving spray. The trees were in ideal condition, and the weather was fine and warm with a fresh breeze from the West. With wastage, a little over a gallon of spray per tree was used. Perfect cover (i.e. a uniform film) was not obtained, but it was as good as usual with lime-sulphur and lead arsenate.

Observations made on 2nd May showed that leaf-burn was not present on C (lead arsenate only). This type of injury was fairly severe, however, on A (lime-sulphur + lead arsenate), most of the early leaves being curled and burnt at the margin. There was a great deal of this type of damage elsewhere in Kent at the same period, which suggests that leaf-condition may have been a predisposing factor. Over-spraying was also a possible contributory factor, although according to information collected from various sources, this was not always coupled with the use of high pressures and driving sprays. Indeed, one instance was noted where severe burning occurred on cordon trees which had been sprayed with the same mixture from a hand-operated machine.

Pink-bud spray. Applied on 4th May, A, B, C and D each receiving the same spray (lime-sulphur + lead arsenate)at 200-250 lbs. pressure. Two men sprayed, using 6 ft. lances and single, adjustable nozzles set to give a medium spray.* The trees were again at an ideal stage, and conditions for spraying were excellent—dull, but warm, with a light westerly breeze. About $1\frac{1}{2}$ galls. of spray per tree was used, and the cover obtained was satisfactory for lime-sulphur and lead arsenate.

Observations made on 11th May showed that leaf-burn was present on all four plots and that this was more extensive than usual for the period. As every effort was made to prevent over-spraying, and a much " softer " spray was used than at green-bud, it seems likely that leaf-condition was concerned in some undetermined way. The effect of the second spray in conjunction with that of the first on A had been to give the trees there a very scorched appearance considerably in excess of that shown by trees on the other three plots.

Petal-fall spray. Applied on 22nd and 23rd May in warm, sunny weather ideal for the effectiveness of nicotine. The $2\frac{1}{2}$ h.p. machine was again used. Two men sprayed, using 4 ft. lances and double nozzles each fitted with a No. 0 disc. A fairly straight, driving spray was obtained, as for the green-bud spraying. All the sprays wetted the leaves and trusses of fruitlets satisfactorily by reason of the spreaders they contained. It was difficult to detect differences between the degree of " cover " shown by the various spray-mixtures. An average of nearly 2 galls. of spray was used for each tree. This included some unavoidable wastage in excess of normal because trouble was experienced with the machine.

* Double nozzles and a driving spray were not used for this application in view of the damage caused at green-bud.

On the unsprayed trees, Scab was already establishing a firm hold on the rosette leaves around the trusses of fruitlets, and heavy infection must have occurred just prior to blossoming. On the sprayed trees, no Scab was seen on A, where two pre-blossom applications were made. A little infection was present here and there on the other three plots. The effect of the pink-bud application was now apparent on all four plots, some leaf-drop, though not serious, having occurred on each sprayed tree. It is not usual for the pink-bud spray of lime-sulphur (1-30) + lead arsenate paste (0·4 per cent.) to cause more than slight marginal leaf-burn on these Cox's, and, as the spraying was, by design, fairly lightly done to obviate leaf-drop, further support is thus given to the surmise that environmental factors in early spring, 1934, had pre-disposed the foliage to injury.

Three-weeks' spray. Applied on 12th June, all four plots being sprayed with lime-sulphur (1-100) + nicotine (6 ozs. per 100 galls., for aphis) and spray-gelatine (1 lb. per 100 galls., to assist Red Spider control). The weather was bright and hot, with cloudy intervals. The 10 h.p. machine was used, and four men sprayed at 350-400 lbs. pressure each with a 4 ft. lance and double nozzle with No. 0 discs. A very driving spray was not used on this occasion as it was not thought necessary, but sufficient force was maintained to enable the spray to penetrate to the inner foliage without merely drifting through. About 2 galls. of spray per tree were used.

At this period, the control trees were severely infested by Red Spider, and to prevent the damage likely to result from the unchecked activities of this pest, these trees were sprayed on 9th June with a 2 per cent. white-oil emulsion + spray gelatine at 0·1 per cent. (nicotine at 8 ozs. per 100 galls. was also included for Aphis and stray Capsids).

Biological Observations and Weather Conditions.

Scab. All the available data indicate that the main period of *primary* infection occurred a few days prior to pink-bud, probably during the last two days of April and the first two or three days of May. The rainfall records* show that in April there was a total fall of 2·87 ins., of which 1·92 ins. fell during the week 22nd to 28th, and 1·67 ins. of this on the three days, 23rd, 27th and 28th. Dead, scabbed leaves, stored during winter in a wire cage resting on the ground in the open, were examined at frequent intervals in April. On the 18th, no ripe ascospores were found. On the 24th and 25th, a few perithecia containing ripe ascospores were found, but the majority were unripe. On the 28th, many perithecia still contained unripe spores, but, in spite of this, ripe spores were present in sufficient quantities to start heavy infection. It was during this period that heavy rain fell. The Cox trees in the spraying trial were then at a stage between green-bud and pink-bud, and had not received their pink-bud application (which was given on 4th May).

After April, generally dry weather prevailed all the summer as the following rainfall data show:

May.	0·71 in. (0·14 in. on 6th, 0·13 in. on 8th, 0·32 in. on 16th).
June.	1·48 ins. (1·0 in. on 23rd).
July.	2·02 ins. (0·12 in. on 12th, 0·31 in. on 13th, 1·02 ins. on 24th).
August.	1·83 ins. (0·45 in. on 12th, 0·32 in. on 13th, 0·52 in. on 28th).
September.	1·38 ins. (0·54 in. on 2nd, 0·32 in. on 19th, 0·24 in. on 22nd).

The pink-bud application proved to be just too late to protect trees from initial infection, although, as the fruit-records will show, post-blossom spraying, coupled with

* The writers are indebted to Mr. H. C. Chapelow for these figures.

the dry summer, prevented severe fruit-infection in spite of every appearance of an epidemic on the rosette leaves at the end of May. These leaves dropped profusely in June.

Sawfly. As in 1933 (4), nicotine was applied with lime-sulphur at petal-fall, before Sawfly eggs had hatched (hatching began on 26th May* and the petal-fall spray was applied on 22nd May). Control of this pest was therefore due to the toxic effect of nicotine on the unhatched egg.

Spray-injury. Apart from the leaf-burn and leaf-drop already mentioned, no further damage was caused by any of the sprays.

Methods Used to Obtain Results.

The results concern only the fruit, dropped and picked. All dropped fruits were collected from underneath each tree from fertilization to picking-time, and graded for Scab, Sawfly and "caterpillar" (Winter Moth, etc.).† The picked‡ fruits from each tree were all similarly graded, while Codlin-attack was also noted. The "category" method (1, 2) was used in Scab-grading, while apples attacked by Sawfly larvae, by Winter Moth and other caterpillars and by Codlin larvae were merely counted and recorded.

For the first time, the picked crop from this plot of Cox's was not all graded. In 1933, although the entire crop was graded, a sampling method was tested and found satisfactory. In 1934, therefore, the sampling method was used for most trees, as the crop was very heavy. The fruits were graded from the orchard boxes into which they had been picked. Two pickings were made (the second, two weeks after the first), and, at each, a random sample from every box was obtained by taking up the first apple touched until a hole had been made through all the layers, and from one-third to one-half of the fruits had been removed.

Results.

A complete table of results will be seen herewith. The treatment is referred to in the tabulated data simply as A, B, C or D—the spray-treatment on each plot is fully set out earlier in the paper.

The results in each case were worked out for each tree, then averaged for similarly-treated trees on the same rootstock.

The Sawfly on the picked crop was disregarded, being of negligible proportions. The number of attacked fruits among the "drops" was expressed as a percentage of the entire crop, dropped and picked.

The percentage reduction due to spray-treatment of Scab and Sawfly is based on the *average* attack on control trees on B and D together.

Discussion of Results.

The Crop. A very heavy crop of excellent fruit was picked from these trees for the second year in succession. *Complete* spray-programmes have been compared for the past two years, while the number of unsprayed control trees (and of those receiving too

* The writers are indebted to Mr. W. Steer for the date of commencement of hatching.

† The writers are greatly indebted to Mr. E. T. Roberts (Imperial College) for much valuable assistance in this work.

‡ Large dropped fruits (windfalls) collected from mid-August till picking-time were recorded among the picked crop.

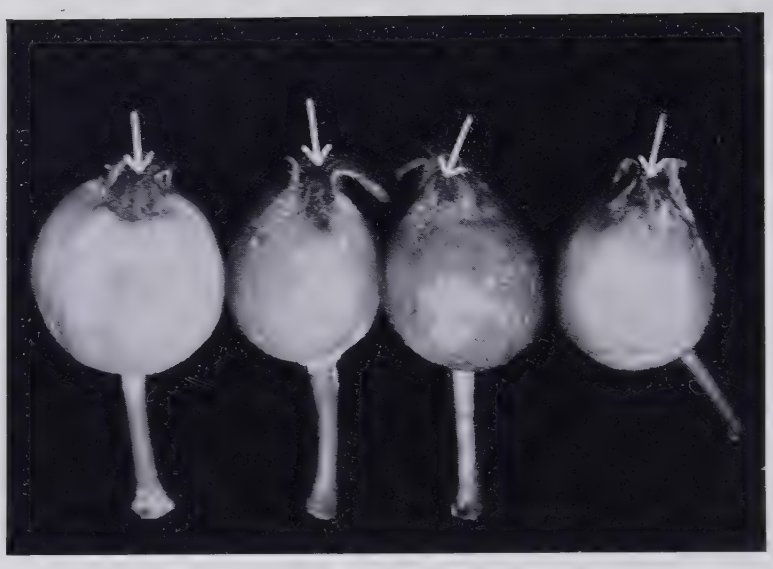


FIG. 1.

Specimen fruitlets, approx. 1½ × natural size, of Cox's Orange Pippin showing very early Scab-infection on the calyx-lobes. This infection progressed on some fruits and not on others, as shown by the mature fruits depicted in Fig. 2.

FIG. 2.

Specimen Cox's Orange Pippin apples, about ⅔ × natural size, showing, from A to E, progressive stages in the development of "eye-infection" by Scab. Slight infection of the calyx-lobes is depicted in A and B, and in C, progression to the skin of the apple has begun. Further developments of this are shown by secondary infections in D and E. Arrows are inserted to indicate the position of the primary infections in A, B and C.

few sprayings) has been very much reduced. Since then, this plot has shown consistency in heavy cropping, due, doubtless, to the better control obtained of pests and diseases.

The total set* in 1934 was even greater than that in 1933. This probably explains, in part, why the percentage of fruit picked in 1934 was generally much lower than that in 1033. Furthermore, lime-sulphur was used stronger at pink-bud and at petal-fall in 1934 than in 1933, and slight spray-induced fruit-drop might thus be a likely contributory factor, for the control trees (on stocks IV and XV) showed a greater average percentage of fruit picked (44·3 per cent.) than the sprayed trees (on the other stocks) collectively (40·0 per cent.). In this instance, the fruit-drop was not of economic importance—it may even have been beneficial in thinning the crop, for no hand-thinning was done.

As in 1933, the percentage of fruit picked from trees on stocks I, III, IV and X is high, while that from trees on No. II and on No. XVI is low. No. II, No. IX and No. XVI have consistently brought a low proportion of the set fruit to maturity during the past three or four seasons, though in 1933, No. IX showed an unexplained exception to this rule.

Scab (*Venturia inaequalis* Aderh.). Study of the classified data leaves no doubt that two pre-blossom sprays were necessary in 1934 for excellent Scab-control at East Malling. When read in conjunction with the biological notes available, they show that pink-bud was a few days too late for the application of a spray designed to prevent primary infection. Two pre-blossom sprays were shown to be necessary also in 1932 (3), but, in that instance, infection was already severe before the pink-bud application was made.

An unusual form of infection was very prevalent in this district in 1934. On many varieties, these Cox's included, widespread infection of the calyx lobes was observed. It was first noticed at mid-June when the dropped fruits were being washed and graded. *Most of the Scab recorded in the tabulated data was of this type.* The wet weather at the end of April was probably responsible for this primary infection, but dry weather after blossoming afforded little opportunity for secondary infection to develop. Hence, even on unsprayed trees, the Scab-equivalent of picked fruits was not high (13·0) although the percentage of fruits infected was fairly high (64·3). Progress of the disease was further checked by the sprays. Each of the three-application programmes of lime-sulphur sprays with either sulphite lye, sulphonated lorol, or " Lethalate " incorporated as spreader at petal-fall, showed fairly good control, with a slight, though almost constant difference in degree of efficiency (on the picked fruit) in favour of the programme containing " Lethalate ".

The " eye-infection " discussed above was kept under observation as the season progressed, and it was seen that on many fruits it had spread downwards on to the cheek by picking-time. The accompanying photographs (Fig. 1 and Fig. 2) show a series of typical fruits which represent stages in the development of this " eye-infection ". Sometimes, secondary infections were noted around the primary ones, as will be seen on two of the mature fruits depicted.

No well-marked influence of rootstock on the degree of Scab-infection is evident in the figures. Trees on No. III, VI, IX and XVI were more lightly infected (as shown by grading the fruits) than those on No. I, II, V, X and XIII, but this arrangement does not conform with previous findings on unsprayed control trees. The effectiveness of the sprays seems to have masked stock-influence, and the slight differences obtained may be

* " Set " is used throughout this paper in reference to the total number of blossoms which, whether completely or incompletely fertilized, produced recognized fruitlets. The figure, for the purpose of these experiments, is the sum of picked and dropped fruits for each tree.

Tabulated Data.

Variety—Cox's Orange Pippin.

Stock.	Treatment.	No. Trees.	Total No. fruit picked.	Total No. fruit dropped.	Total No. fruit produced ("set").	Average per Tree per Rootstock.				
						% Picked.	% Sawfly (all fruit).	% Scab. (all fruit).	% Scab. (picked fruit only).	Scab-equivalent (picked fruit only).
I	A	4	867	530	1,397	67·1	1·0	5·1	5·3	0·7
	B	4	950	1,515	2,465	50·1	1·2	25·0	39·0	5·4
	C	4	1,157	876	2,033	65·0	1·2	23·2	34·1	4·4
	D	4	1,375	1,343	2,718	54·0	0·8	19·0	27·1	4·0
						59·1				
II	A	4	1,407	3,022	4,429	31·7	4·9	7·1	8·1	1·0
	B	4	1,551	2,637	4,188	38·2	0·8	21·9	26·7	3·4
	C	4	1,447	3,324	4,471	32·8	3·9	20·8	30·4	4·4
	D	4	1,940	5,605	7,545	25·8	2·7	24·2	30·6	4·6
						32·1				
III	A	4	657	582	1,239	54·1	1·7	7·2	6·7	0·8
	B	4	1,052	781	1,833	59·9	0·8	10·9	13·0	1·8
	C	4	1,119	934	2,053	59·4	1·1	25·6	24·9	3·4
	D	4	1,221	1,923	3,144	40·2	1·4	25·2	29·2	4·5
						53·4				
IV*	B	4	3,690	3,943	7,633	56·4	13·8	53·6	85·4	17·8
	—									
	D	4	3,011	5,049	8,060	38·0	26·8	30·7	51·3	9·8
						47·2	20·3	42·4	68·4	13·8
V	A	4	1,052	1,114	2,166	53·3	1·0	6·4	6·6	0·9
	B	4	1,140	3,632	4,772	25·5	0·8	22·5	33·6	5·0
	C	4	1,595	4,378	5,973	26·9	1·5	21·6	35·9	5·9
	D	4	1,756	3,250	5,006	39·4	3·1	25·6	39·2	5·6
						36·3				
VI	A	8	1,158	2,379	3,537	38·3	1·8	3·8	4·4	0·6
	C	7	3,721	5,284	9,005	43·2	2·0	24·0	29·8	4·3
						40·4				
IX	A	4	1,076	1,800	2,876	38·2	1·1	7·2	7·9	1·0
	B	4	840	834	1,674	22·3	0·7	21·9	19·2	2·4
	C	4	1,176	1,177	2,353	22·8	1·8	20·8	21·5	2·9
	D	4	1,132	3,435	4,567	25·9	1·2	18·9	21·2	2·8
						27·3				
X	A	3	1,027	1,399	2,426	45·5	4·8	10·9	9·0	1·7
	B	4	1,849	2,101	3,950	48·4	1·0	25·8	37·9	5·7
	C	4	1,447	974	2,421	61·0	1·6	26·3	37·0	5·4
	D	4	1,471	2,178	3,649	43·9	1·3	30·8	37·4	5·2
						49·7				
XIII	A	4	742	1,830	2,572	30·1	2·9	11·9	14·9	2·1
	B	4	947	3,460	4,407	52·0	2·0	25·8	26·5	4·3
	C	4	991	3,385	4,376	45·1	2·6	26·3	28·8	4·5
	D	4	1,095	4,342	5,437	20·2	2·0	17·7	31·4	5·2
						36·9				
XV*	B	4	1,514	2,444	3,958	39·3	14·7	51·6	77·7	17·2
	—									
	D	4	1,146	1,515	2,661	43·2	21·9	29·2	46·4	7·3
						41·3	18·3	40·8	62·1	12·3
XVI	A	4	898	3,335	4,233	23·0	5·1	8·5	9·9	1·3
	B	4	1,133	2,916	4,049	28·5	2·6	14·5	18·1	2·6
	C	4	1,341	3,571	4,912	27·6	3·7	20·3	26·1	4·0
	D	4	973	3,354	4,327	19·6	2·1	24·3	29·7	3·8
						24·7				

* All trees on Stocks No. IV and No. XV were unsprayed controls.

merely due to the introduction of another variable factor—spraying—on trees of widely differing size.

Sawfly (*Hoplocampa testudinea* Klug.). There was less infestation on control trees in 1934 (19·3 per cent.) than in 1933 (30·15 per cent.). Excellent control resulted from the use of each of the four spray-programmes, giving 90 per cent. reduction of infestation on sprayed trees (in the aggregate) compared with controls. It is highly probable that this beneficial effect was wholly due to the use of the combined sprays containing

Summary of Results in Tabulated Data.

Average for all Rootstocks.

Sub-plot.	Treatment.*	% Picked.	% Sawfly (all fruit).	% Scab. (all fruit).	% Scab. (picked fruit only).	Scab-equivalent (picked fruit only).
A	LS.A. LS.A. —— LS.N.S. lye. LS.N.G.	42·4	2·7	7·6	8·1	1·1
B	LS.A. —— LS.N.Leth. LS.N.G.	40·6	1·2	21·0	26·8	3·8
C	A. LS.A. —— LS.N.S. lye. LS.N.G.	42·6	2·2	23·2	29·8	4·4
D	LS.A. —— LS.N.S. lorol. LS.N.G.	33·7	1·8	23·2	30·7	4·5
—	Unsprayed.	**44·2**	**19·3**	**41·3**	**64·3**	**13·0**
Reduction due to Treatment :						
A			86%	82%	87%	92%
B			94%	49%	58%	71%
C			89%	44%	54%	66%
D			91%	44%	52%	65%

* For explanation of symbols see under " Description of Experiments " in text. The short horizontal line separating the symbols indicates the blossom period.

nicotine at petal-fall, before the Sawfly larvae hatched. In 1933 (4), 84 per cent. reduction of infestation was similarly obtained, and the results given in that year are therefore sufficiently confirmed to form the basis of a recommendation.

The differences between the figures for treatments B, C and D are probably too small to be statistically significant. Nevertheless, they suggest that " Lethalate " was slightly superior to sulphonated lorol and to sulphite lye as an aid to nicotine in respect of Sawfly-control; this slight difference is constant for nearly every stock-scion combination.

" Caterpillar " (*Winter Moth, early Tortrix, etc.*) and **Codlin** (*Laspeyresia pomonella*). The picked and dropped fruits were graded for " caterpillar "-attack, and the picked fruits, including windfalls, for Codlin, but the results were so variable that it is not considered profitable to present them here.

Infestation by " caterpillar " on the controls was very low, averaging 4·8 per cent., while that on all sprayed trees averaged 2·4 per cent. There was also slightly less Codlin-damage on sprayed trees than on controls, but the difference was not statistically significant.

Red Spider (*Oligonychus ulmi* Koch.). Records of infestation were not made, but the *unsprayed* trees were showing signs of severe attack in early June, and they were specially sprayed, therefore, as already stated. The sprayed trees on A, B, C and D were very free from this pest throughout the season, and they required no treatment additional to the experimental sprays.

Summary.

In 1934, for the second time during the past nine years at East Malling, two pre-blossom sprays (one at green-bud and the other at pink-bud) were necessary for excellent control of Apple Scab on Cox's Orange Pippin. Fairly good control was given by one pre-blossom (pink-bud) followed by two post-blossom applications of lime-sulphur to which, at petal-fall, nicotine was added, with sulphonated lorol, " Lethalate " Wetting Preparation or sulphite lye as spreader. An application at pink-bud was just too late to prevent primary infection, which was very prevalent as " eye-infection " on the calyx-lobes.

Scab-infection at no period reached epidemic proportions, even on unsprayed trees, owing to the dry season, which further aided the efficacy of the spray-treatments.

Very good control of Sawfly and of Red Spider was obtained with all spray-treatments, the effect against Sawfly being due to action on the unhatched egg, as in 1933.

The results revealed little difference in efficiency (concerning Scab and Sawfly-control) between the three spreaders compared ; there was some evidence, however, of a slight differential effect in favour of " Lethalate ".

Caterpillar-attack (Winter Moth, etc.) was very slight, and the results, being very variable, were inconclusive, though all spray-treatments effected slight reduction in infestation. No significant difference was shown between Codlin-attack on controls and that on sprayed trees. Large crops were borne by all trees, although some fruit-drop occurred, probably induced, in part, by spraying.

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ON A NEW METHOD FOR PRECISION TESTING IN THE LABORATORY OF THE TOXICITY OF LIME-SULPHUR AND OF BORDEAUX MIXTURE AS PROTECTIVE FUNGICIDES

A PROGRESS REPORT

By H. B. S. MONTGOMERY and M. H. MOORE

Introductory.

In the control of plant diseases by spraying, much valuable time and material tend to be wasted in testing fungicides through the medium of field trials. This is due largely to the uncertainty of natural infection by the causal organisms concerned. It was observed particularly in 1933 and 1934 that large-scale field trials failed to give detailed results in the control of Apple Scab (*Venturia inaequalis* Aderh.) as weather conditions were not favourable to the development of the disease. Moreover, where new products are concerned, it would be valuable to have some indication of their potentialities as fungicides before they reach the stage of the field trial, for the ineffective products could then be eliminated at a very early stage.

In view of the above, a preliminary investigation of laboratory methods, using *Venturia inaequalis* (spores) as the test fungus, and lime-sulphur or Bordeaux mixture as the test fungicide, was begun by the writers in autumn, 1934. The promising field for further work opened up by this early survey of the problem is described below.

Literature.

The literature on the subject, though very limited, showed that a number of workers (also using *V. inaequalis* for testing) had evolved certain methods which can briefly be classified as follows :

1. The fungicide is incorporated with an agar culture of the fungus, and growth reactions of the latter are noted.
2. The spores of the fungus are placed in liquid fungicide, and the percentage germination is recorded.
3. Glass slides are sprayed with the fungicide, and drops of spore-suspension are added after the spray-deposit has dried.

A few modifications of these methods were noted, but the principles remained the same.

The first two methods were considered unsatisfactory for testing protective fungicides, though they may prove useful in evaluating disinfectants. The third method is satisfactory in principle, but was rejected chiefly on account of the difficulty of standardizing the application and the distribution of fungicide by means of spraying.

The following method of approach was therefore chosen in developing the technique of the new method to be described.

Standardizing the Application of Spray-Fluid.

A protective fungicide (such as is necessary for Scab-control) must be applied before infection by the fungus occurs, and its chief value lies in its ability to remain toxic, after initial drying, over a period of several weeks. Hence, the first point was to ensure that the fungicide was *in situ* and dry before the spores were applied. Since it was considered essential that the amount of spray applied should be constant in every case, a method that depended on visual estimation of the quantity and quality of the " cover " obtained by spraying with a hand-atomizer was deemed too indefinite. The possibility was considered of using the Tattersfield apparatus for delivering a known amount of spray-fluid uniformly spread over a given area. However, apart from the fact that this apparatus, as at present constructed, might not readily deliver spray-fluids in suspension form, and might be attacked by corrosives, it was found that, with sprays of high surface tension, droplets formed on chemically clean glass slides* tended to run together to give a broken film.

Under field conditions, the occurrence of different types of spray-deposit on the leaf-surface will depend largely on the properties of the spray used. As it seemed undesirable to introduce variation of this kind into the laboratory tests, it was decided to use the thinnest complete film of liquid practicable on the glass slides. Spraying methods were ruled out, therefore, as they failed to give this degree of cover where sprays of high surface tension were concerned. Similarly, a method involving the dipping of glass slides into the spray-fluid was discarded because the amount of liquid retained by the slide would vary with the physical properties of the spray-fluid used. Drops from a standard dropping pipette would vary in size for the same reason, so the amount of liquid in a drop was standardized by graduating the pipette. The area of spread of the standard drop on a glass slide was found to vary in size, again according to the physical properties of the spray-fluid. The area of spread, as well as the volume of the drop, was therefore standardized.

A ring 15 mm. in diameter, marked on the slide, enclosed a convenient area for the purpose. Methods were tested to find a suitable way of marking this ring. The slide was rotated on a turntable, and the ring was painted on with waterproof Indian ink. When the drop was applied, however, the ring of ink floated on the surface. Collodion was open to a similar objection. Club Black gave an excellent ring, and the problem appeared to be solved, but some of the Club Black was absorbed into the spray-deposit after this had been allowed to dry in contact with the ring.

The use of any foreign matter as a paint was therefore rejected, and etching was next considered. Slides were masked with paraffin wax, and a groove of the required size was made in it by means of a cork-borer. Hydrofluoric acid was run into the groove and allowed to remain there for about five minutes. The etching, however, was unsatisfactory, as the etched ring was incomplete.

Finally, the necessary rings were cut by using a diamond and rotating the slides in a lathe. This proved very satisfactory, and the method was adopted throughout.

The next problem was to determine how the desired standard of cover of this enclosed area could best be obtained. It was decided to use only different dilutions of lime-sulphur concentrate until the method was sufficiently established to enable different spray-fluids to be critically compared. Up to the present, Bordeaux mixture is the only other fungicide to which the method has been applied.

* Glass slides were used because the work could be done at any period in the year. The use of apple leaves would, at present, restrict the working of the method to the growing season, and attempts are being made, therefore, to produce supplies of leaves " out of season ".

Trials were made with a fine glass tube fitted with a small teat (such as is found in the B.D.H. Capillator Case for determining pH), and 0·015 c.cm. of liquid gave the required cover. It was found that the slides must be *very* carefully cleaned with chemicals beforehand. The cleaning process entailed the use of the following chemicals in order—warm dilute nitric acid (to remove lime-sulphur deposit formed in previous tests), dilute caustic soda (to remove grease), chromic acid cleaning solution and ether (to remove any fats remaining). The slides were washed with water between each two operations, and were transferred from ether to absolute alcohol, where they remained until use. They were each flamed and allowed to cool before the spray-fluid was applied.

Investigation of Methods of Raising Supplies of Scab Spores (*Conidia*).

This was carried on concurrently with the work described above. This aspect of the work was standardized as much as possible so that the complete method could then be established under standard conditions. Accordingly, a culture grown from a single ascospore, derived from a perithecium on a leaf of the Bramley's Seedling apple, was used as the original parent of all colonies raised for the tests.

Since several workers have noted that pure cultures of fungi derived from spores tend to sporulate more freely than those derived from mycelium, only spores (conidia) were used for making sub-cultures. The poured-plate method of spore-production, successfully adopted with other fungi, seemed likely to be suitable in this case. However, although poured-plate cultures were produced under standard conditions, difficulty was experienced in obtaining an adequate supply, in a water suspension, of the spores present. Many of the spores were formed in, rather than on the surface of the medium,* and even those on the surface were not easily removed by flooding the plate with water because of the air-lock formed by the dense aërial growth. Spraying the surface with distilled water from an atomizer overcame the difficulty of the air-lock, but failed to give enough spores for the tests. These attempts led up to the use of a mere film of agar obtained by rotating, horizontally, tubes each containing 0·5 c.c. of warm 2 per cent. malt agar (at 44° C.). The film was allowed to cool, and was then sprayed with spore-suspension from an atomizer. This method proved very successful. After two weeks' growth, a high proportion of spores in relation to mycelium was obtained, and these were readily detached when three or four c.c. of sterile distilled water were introduced into the tube and shaken up. Two tubes gave sufficient spore-suspension of suitable concentration (about fifty spores per 2 mm. low-power field) for each series of tests. About six poured plates were required to give a similar spore-concentration (after the surface had been scraped with a sterile scalpel), and the suspension had to be filtered through sterile muslin to remove particles of mycelium present. In this process, many of the spores failed to pass the filter.

Sterilized pieces of three- or four-year-old apple branch were also used as medium. Split portions about 3 ins. long were peeled of bark and placed singly in tubes with a little water. After autoclaving, these were sprayed with spore-suspension in the same way as the agar films. This method also proved successful.

Palmiter (Phytopath., 1934, **24,** pages 22-47) mentions a method of raising Scab spores on cheese-cloth wicks soaked in malt extract. This method was tried, but, so far, it has not provided adequate quantities of spores.

All these cultures were grown in an incubator kept at 21°-22° C. Some were removed to a lower temperature (15°-18° C.) in an attempt to accelerate sporing, but this was not successful.

* Both malt agar and Dox (with maltose instead of sucrose) were used.

Standardizing the Application of Spores.

Methods of applying the spore-suspension were investigated. Spraying was rejected because of the difficulty of standardizing the application (as with the spray-fluid). A standard drop of 0·015 c.c. was applied from the pipette used for the spray-fluid. This method was fairly satisfactory, but the distribution of spores was not uniform.

The next step was to apply five drops separately on each marked-off area by means of a standard platinum loop of about 2·5 mm. diameter. These drops tended to dry out before the spores had germinated, and some very curious results were obtained. For example, lime-sulphur at 1 in 100 gave less germination than at 1 in 50, because the drop on the former dried out while that on the latter did not. The spore-suspension was found to spread more readily on the weaker deposit than on the stronger, and the thinner film thus formed dried more rapidly. It was therefore decided that a standard drop must be applied over a standard area, and, to prevent drying-out, the original method of using one drop from the pipette was reverted to and the quantity of spore-suspension was increased to 0·05 c.c.

Procedure at Present Adopted for Making the Tests.

Lime-sulphur concentrate at dilutions in distilled water of 1 in 10, 1 in 25, 1 in 50, 1 in 100 and 1 in 200 were compared in each series with a distilled water control.

After dilution, 0·015 c.c.* of the spray fluid was dropped on to the marked-off area on the slide from the graduated fine-glass tube mentioned above. Ten slides were used for each dilution and ten for the controls. Where the spray-fluid failed to spread out to the groove, it was drawn to the edge with a finely-pointed glass rod. The deposit was allowed to dry in the laboratory atmosphere, and the slides were then stored for three days in an unheated water oven (temp. approx. 15°-18° C.). This was done to simulate in some degree the temperature conditions prevailing in the field in spring. The period of storage has now been shortened to one day.

Some hours before the application of the spore-suspension, moist chambers were prepared by lining potato-dishes with wet filter-paper at top and bottom. The slides rested on glass tubing which raised them from the wet filter-paper. Later, filter-paper was not used, for the growth of moulds on it would tend to affect the atmosphere in the moist chamber, which in turn, might influence spore-germination.† A pool of distilled water is now used instead.

The spore-suspension (0·05 c.c.) was applied as indicated above, and spread to the groove, where necessary, with the glass needle. Each series of ten slides was placed in a separate moist chamber to obviate the possibility of interference by volatile products from other dilutions.

After twenty-four hours, counting was commenced. It was found necessary to count high-power fields, because the density of the spray-deposit at the greater strengths made it practically impossible to see the spores with low power. Ten high-power fields were taken at random on each slide, and the germination was recorded. Three categories of spores were used, those showing (a) no germ-tube (*ungerminated*), (b) germ-tube up to length of spore (*inhibited after germination*), (c) germ-tube longer than spore (*germinated*). The counts on each of ten slides were added, and the totals of 100 high-power fields were ultimately compared.

* In one series, 0·02 c.c. of the spray-fluid was used. It was found, however, that the greater quantity proved more toxic to the spores, and afterwards 0·015 c.c. was always used.

† The writers are indebted to Prof. W. Brown (Imperial College) for this suggestion.

When sufficient tests had been made with lime-sulphur to give constant results, the same method of procedure was used for comparing Bordeaux mixtures containing 1·0%, 0·8%, 0·6%, 0·4% and 0·2% copper sulphate with a distilled-water control. Hydrated lime was used in each at the constant ratio of 3 parts lime to 2 parts copper sulphate. As all these mixtures prevented spore-germination, a range of greater dilutions was tested. These contained 0·2%, 0·15%, 0·1%, 0·05% and 0·025% copper sulphate. None of these mixtures allowed free germination.

Experiments in the field have shown that reduction in the copper content of Bordeaux mixture from 0·8% to 0·4% results in decrease in the efficiency of this spray against Apple Scab. Since the glass-slide method described above did not show differences in toxicity over a wide range of dilutions, attempts are being made to reproduce as nearly as possible one of the factors (e.g. rain) which may be responsible for differences of " performance " under field conditions. This is being done by washing under known conditions the standard Bordeaux deposit on the slides.

It is desirable to emphasize that many points of technique mentioned in this progress report have been developed only during the few weeks prior to going to press, and the writers have not yet had sufficient experience of them to be confident that they cannot be improved. The method is still at a preliminary stage, and much more work is necessary before it can be offered as a standard method of testing.

Results.

The results obtained up to the present are necessarily scanty, for the time has been mainly occupied in developing the technique. However, such results as have been obtained are promising, and it is hoped that further development of the method will render it generally applicable to all kinds of protective fungicides. Among other things,

Summary of Results with Lime-Sulphur.

Treatment.	Spore-counts. (a) Germinated.	(b) Inhibited after initial germination.	(c) Ungerminated.	Average of : Slides.
First experiment :				
Control ..	103	2	5	7
1–200 ..	17	31	51	8
1–100 ..	10	39	53	10
1– 50 ..	4	28	65	10
1– 25 ..	1	5	98	5
1– 10 ..	0	0	109	5
Second experiment :				
Control ..	94	1	7	9
1–200 ..	20	48	34	10
1–100 ..	8	43	44	10
1– 50 ..	1	9	96	9
1– 25 ..	1	2	103	10
1– 10 ..	1	1	112	10

Note.—Ten slides constituted a series in each treatment. General inspection of the slides showed that, in certain series, the effect of treatment was very uniform throughout. To save time, therefore, spore-counts were not made on all ten slides in these series.

attention is being paid to the possibilities of modifying the surface of the marked-off area on the glass slide (not by the use of foreign substances but, perhaps, by etching) to facilitate the spreading of spray-fluids of high surface tension.

Appendix.

The laboratory method described in this progress report is regarded as only the first stage in a programme of thorough tests of protective fungicides. By its use, the minimum concentration of spray-fluids toxic to the spores of *Venturia inaequalis* can be determined, and the relative values of different spray-fluids can be compared. Any new products showing distinct promise on the glass slides would, of course, be required to sustain this promise when tested on apple trees. Thus, the second stage will be to carry out small trials with such products on apple trees growing in pots under controlled conditions in the greenhouse. In this connection, experiments designed to shorten the normal dormant period are being undertaken.

This second stage would be a preliminary to testing the products experimentally and commercially on a field scale, when any relationship existing between the reaction of the products under standardized conditions on the glass slides and under normal field conditions on the trees would be established.

Summary.

A new method is described for testing under laboratory conditions the toxicity of lime-sulphur and of Bordeaux mixture, used as protective fungicides, to spores (conidia) of *Venturia inaequalis* Aderh. The method is still at a preliminary stage.

The paper deals with the problems confronted in standardizing the application of spray-fluid and of spores, and includes a discussion of the best means of raising in pure culture large supplies of viable spores.

Section IV

BULLETINS FOR FRUITGROWERS

POMOLOGY

EAST MALLING'S EXPERIENCES WITH APPLE ROOTSTOCKS*

By R. G. HATTON

Most of you are aware that just over twenty-one years ago an investigation into the so-called " Paradise " apple rootstocks was begun at East Malling. You know that by 1917 we had discovered that there were at least nine varieties of " Paradise " and " Doucin " in commercial circulation (often intermixed) and as many more about to be introduced. All these were readily distinguishable by the characteristics of their wood and foliage but nevertheless there existed considerable confusion and mixture of varieties. It was for this reason alone that we adopted the system, since adhered to, of giving index numbers or letters rather than names which are even yet in dispute. During the Winters of 1918, '19 and '20 we were able to plant out maiden trees of Lane's Prince Albert, Bramley Seedling, Worcester Pearmain and Cox's Orange Pippin for trial upon most of these rootstocks, not only at East Malling on the Malling series of the Lower Greensand formation, but also on a number of other soils in Kent, Surrey and Sussex—ranging from the Bagshot Sands at Wisley to the Weald Clay at Wisborough Green.

Since then there have appeared a series of progress reports upon the behaviour of these varieties upon the different rootstocks at different stages of their development. Although the story is now so well known, I am going to try and summarize the chief considerations which have emerged as being likely to affect the choice and practice of the nurseryman and grower.

Nursery Performance.

From the nurseryman's point of view certain varieties of rootstock were much more desirable than others in that they throw up a larger number of suckers and rooted and transplanted more readily (such as II and I). Again, some of these varieties were in themselves more prone to leaf scorch (V), scab, mildew (III), canker (VIII), and crown gall diseases (VII, XI). Some were more liable to split in a hard Winter (VI) or dry out in a dry Summer (IV). Others, after budding or grafting, formed a " union " more rapidly and definitely took the scion better. Finally some produced a better looking maiden tree than others ; some " ran up " as standards more quickly. Unfortunately, few if any of the sixteen varieties of rootstock, which it must be remembered were originally largely the haphazard selection of commerce, proved to be the ideal in all these

* This paper was read at the Growers' Day Conference at the Imperial Fruit Show, Leicester, and is here reprinted by kind permission of the *Fruit-Grower*.

respects. Nor has it by any means been the case that the rootstock which itself was most vigorous, ready rooting or disease resistant, necessarily produced the best growing, most healthy tree in the end. However, at least six varieties (Nos. I, II, IX, XII, XIII and XVI) came through these prolonged trials satisfactorily and have established themselves in more or less common use to-day.

The growing plantations of worked trees have certainly made us revise most preconceived ideas about " Paradise " rootstocks from start to finish.

Soil and Management.

Whilst different soils, probably as a result of some limiting factor, do tend to lessen or accentuate the actual influence of the rootstock upon the scion, they rarely, if ever, alter the *relative* effect as was at one time suspected. For instance, whilst Lane's Prince Albert trees on Nos. IX and XII have universally represented the most dwarfed and most vigorous trees respectively in the series, the former combination made practically no growth at Wisley yet on the Malling loam it formed a bush tree filling 9 feet square in ten years. On the other hand the latter (XII) has been characterized by super-abundant vigour and slow bearing at Malling yet of excellent growth and cropping on the sand at Wisley. However, it has been impossible to generalize from such manifestations that certain soil types are " too strong " for trees on No. XII, or that the use of No. IX must be confined to very specialized conditions. The grassing down of the one and the " high " farming of the other may be all that is required. Indeed all those factors summed up in the word " management " are of supreme importance in relation to the successful exploitation of rootstock influence.

It has become abundantly clear, for instance, that the same variety upon different root-systems growing within a few yards of one another will react very differently not merely in degree but actually in direction also, to the same manurial programme. For instance, in our manurial experiments with Bramley's, between thirteen and sixteen years old upon different rootstocks, the trees on Nonsuch (VI) " increased markedly in vigour and cropping under all treatments, though still showing manurial effects " whilst the poor cropping of the trees on Improved Doucin (V) was made still worse by nitrogen applications. Again, similar plots of Worcester Pearmain having received no manure for sixteen years, exhibit a striking contrast on different rootstocks so far as potash deficiency symptoms (" leaf scorch ") are concerned. The now well-known susceptibility of trees on No. V to leaf scorch is outstanding here.

When the effect of grassing down upon Worcester Pearmain on the same series of rootstocks was studied, fruit size was found to be reduced in two consecutive seasons on all trees except those worked on Nos. V and XVI. As regards colour, the trees on the former (V) were affected to a greater extent than on the latter (XVI). Thus different rootstocks do not necessarily respond in a similar manner to the same " management " which must therefore be modified accordingly.

Type of Tree and Distance.

These and similar facts must lead the grower on to the consideration of the most suitable type of tree and distance at which to plant. Here again the trial plantations at East Malling confront us with facts which speak for themselves. In 1919 a most august committee of fruitgrowers accused us of wasting land when we alternated trees of Bramley's Seedling and Worcester Pearmain at 15 feet square, on the ground that no trees on " the Paradise " could fill more than 10 or at most 12 feet square of space. So crowded was this very plantation twelve years later that all the Worcester Pearmain

trees had to be removed and the Bramley's laid down to grass to check growth, although of course " the Paradise " was known not to survive in grass. To-day, two years after the removal of the Worcesters, these Bramley's even on the Doucin (No. II) and the Broadleaf (No. I) in grass are touching, and often overlapping, while even the trees on No. IX roots continue to grow and crop.

Plantations on " the Paradise " were moreover alleged to have a profitable life of about twenty years, and by analogy, those on No. IX from ten to fifteen. Even on this latter stock, I see rising up to bear witness against me, vigorous little bushes struggling in healthy rivalry for space at 8 feet square, under such contrasting conditions as the " Hythe Beds " and the " Folkestone Sand " in Surrey ; the " Malm " in Hampshire ; and the " Hythe Beds " and " Wealden Clay " of Sussex. At East Malling the demise of these dwarf bushes is surely overdue, yet despite little or no pruning in some cases, check from grassing down in others (and the drain of continuous cropping over more than a ten-year period), after two years of drought they exhibit good foliage and at least a foot of new terminal growth !

Whilst, depending upon the rootstock, the bushes of Lane's Prince Albert occupy from 9 (IX) to 17 (XII) feet square, the total weight of the Worcester Pearmain trees when lifted at fourteen years averaged 47 lbs. per tree on No. IX, 107 lbs. on No. I, 155 lbs. on No. II, and 226 lbs. on No. XII ! But even these immense contrasts in spread and weight of tree by no means tells the whole " growth " story. Certain rootstocks (IV and VII) have been proved to grow very vigorously *at one period* of their development —and to bear early as well—then they are passed in growth by trees on other rootstocks formerly of the same size, and they finally " settle down " as semi-dwarf bush trees. Alternatively young trees on other rootstocks (XVI) do not seem to " get into their full stride " of growth in the first few years. It is obvious that such behaviour has made it essential to qualify the old simple grouping of apple rootstocks upon a purely " vigour " basis by saying that this vigour must be related to soil variety and, as we have since learnt, even to a particular period of the tree's life. It is quite true that all varieties on No. IX have so far remained comparatively the most dwarfed under any set of environmental conditions, and on XII and XVI have become the most vigorous. But I know of a disappointed owner of rich land starting to root prune his trees on IX because they did too well, and I even know of places where trees on No. XII make an ideal bush tree ! The Doucin (II) with the majority of varieties and under many soil conditions has long since strode out of the " semi-dwarf " group to join in the race and even outstrip Broadleaf (I), leaving the once vigorous unnamed No. VII, and once very vigorous Holstein Doucin (IV) to represent the true semi-dwarf. Unfortunately both these last stocks possess faults which have been judged sufficiently serious to prevent their general recommendation. The ideal semi-dwarf—more of a man than No. IX and less of a giant than Nos. II and I—is still being sought by breeding and testing because I believe the best type of tree for general modern requirements will so be attained.

However, our oldest trees on known rootstocks are but seventeen years and there may still be surprises in store but surely the idea of " the Paradise " suitable in theory for planting at 8 feet square under any conditions and destined for a short life and a merry one has vanished for ever, and left the intelligent grower with an invaluable range of characteristics to choose from according to his conditions and purpose.

Cropping.

In determining his plan of planting, and in choosing the most suitable material for his purpose, the grower must of course consider the potentialities of his tree not only for growth but also for cropping. If, once again, he relies upon trees on " the Paradise "

to give him accelerated cropping he may be sorely disappointed. He must consider cropping potentialities from several aspects.

Early Bearing.

Our experiments have demonstrated conclusively that there are very material differences in earliness of coming into cropping amongst these so-called " Paradise " stocks. In all comparisons, up to the end of the fifth year trees on the Jaune de Metz (IX) have been well ahead in cropping—in the case of Bramley's and Lane's having produced nearly half a bushel a tree, in comparison with at most 6 or 7 lbs. on any other stock.

This pre-eminence is maintained up to the end of the ninth or tenth year, with the exception of Worcester which on No. IV equals it from the fifth to seventh year and exceeds it from that time onwards.

Trees on Jaune de Metz (IX) were followed by a considerable intermediate group (including Nos. I and II) the outstanding examples of which are the unnamed No. VII and Holstein Doucin, No. IV, in earliness of cropping, which usually bore their first half bushel somewhere between the sixth and eighth years. The very vigorous stocks did not reach this weight of fruit before the eighth or ninth year at earliest.

These differences in earliness of cropping, taken in conjunction with tree size have been shown elsewhere to make very striking differences in crop per acre at least to the end of the first thirteen years—differences in the region of from five to ten times the crop according to variety, in favour of the more rapidly productive stocks.

Accumulated Total Crop per Tree.

In the accumulated total crop figures of all four of the scion varieties (at from fourteen to sixteen years of age) there are two immediately outstanding facts. First, the trees on one rootstock (Holstein Doucin IV) in every case head the list, though in the case of Lane's Prince Albert they are bracketed with those on two other stocks (I and XVI). Second, in all four cases the trees on the so-called Improved Doucin (V) stand well towards the bottom of the list with roughly only 60 per cent. of the crop on IV. Incidentally this stock (V) has in every comparison with trees of similar vigour, cropped less heavily. When compared with the true Doucin (II) it is always strikingly inferior, and in only one case has its cropping as yet exceeded that of trees on Jaune de Metz (IX) which are only about quarter the size. As another admirable instance of the influence upon cropping of a suitable and unsuitable rootstock the crops per tree of sixteen-year-old Bramley's on No. X at 12 bushels, and on IV at 35, may be cited.

There is a very encouraging general consistency throughout these trials in the behaviour of different varieties upon any one rootstock though as time goes on the signs of particular partialities becomes more evident. For instance when worked with Bramley's, Lane's and Worcester, Broadleaf (I) has (after the first few years) maintained (to date) supremacy in total crop over Doucin No. II, whilst in the case of Cox's Orange Pippin the situation in the thirteenth and fourteenth years was reversed materially in favour of the Doucin No. II, which incidentally has always been the more vigorous tree. This is probably not an isolated case.

Of the very vigorous stocks, Nos. XII and XVI, the latter has in all comparisons of total cropping been significantly more prolific.

Total Bearing Capacity.

Having taken into account the questions of earliness of bearing and the total accumulated crop per tree, it remains to consider the maximum capacity for bearing of

these various combinations. The highest crop in the optimum year of any one variety on the series of stocks is not a fair measure of the tree's capacity but it does to some extent illustrate the potential bearing area to date. For instance whilst the heaviest crop of Lane's on IX has been 74 lbs. (in 1929), the highest total on IV has been 167 lbs. (in 1933), that on I has been 231 lbs. (1933), on II, 190 lbs. (1933), and on XII 169 lbs. (1934). But whereas with stocks like IX and IV the present indications are that these maxima are unlikely to be greatly exceeded at least with an early maturing variety such as Lane's it appears obvious that at least trees on XII have not yet reached their highest point even with this variety.

If the average crops of the three varieties on the different rootstocks during the past six years (i.e. the period immediately following the " early bearing " one), be examined it will be found that the general tendency of the crops on Nos. IX, VII, and to a lesser extent IV, is to become stabilized closely around the average, trees on IV producing nearly double the crops on IX and those on VII holding an intermediate position, whilst trees on stocks of the other intermediate and more vigorous types are not infrequently more fluctuating but reaching a higher level from year to year or at least in each alternate year. At present there is no sign that the quantity or quality of fruit from the more stabilized—and presumably " mature "—trees is deteriorating, and the healthy growth which is generally maintained suggests that there is no reason to expect this to be so. The only possible exceptions are the very heavy cropping trees on No. IV which have received no manure for sixteen years and are suffering severely in consequence. On the other hand, as the quantity of fruit increases on the most vigorous rootstocks it seems apparent that the quality, which was definitely poor in the early years, is improving.

Fruit Quality.

Apart from this general tendency, rootstock influence has been shown to have a more direct effect upon size, colour and keeping quality. Outstanding cases are the exceptional colour (and size in the early years) of fruit from trees on No. IX, the usually small fruit of poor appearance off No. V and the *comparatively* poor keeping quality under certain cold storage conditions, of fruit off trees on IV and VII as recently described by Dr. Wallace of Long Ashton, who has also recorded that under similar environmental conditions there are significant differences as well in the chemical composition of the fruit —and hence in " quality " and taste.

It now seems generally recognized that the fruits off IX ripen earlier than on most other rootstocks and that for storage purposes they require earlier picking. Comparative experiments taking this factor into account have on several occasions failed to reveal any significant difference in the keeping quality of Lane's or Bramley's on IX, II, I or XVI.

Knowledge of Rootstock Matters.

When all these aspects have been reviewed and all the interesting factors of variety, soil, manurial and cultural conditions have been recalled, it is obviously impossible to expect any rule of thumb advice with regard to the selection of the best rootstock. Rootstock is but one of many factors capable of doing its part in producing the optimum tree. Like the soil, the tree is the fruitgrower's " stock in trade " which is there for good and all, although if we know enough about it we may be able to improve its productivity through suitable manurial and cultural treatments. But in so doing we can never be too often reminded that " *different rootstocks respond differently to differing environmental conditions* "—to quote Dr. Wallace once again.

While we are not likely—after all the weight of evidence—to join in the chorus that "rootstock doesn't matter", it is worth trying to understand the basis of this argument. Probably it is thought that, since so much can now be done to control the tree by cultural and manurial operations, it is possible to compel the tree material to adapt itself to one's particular requirements regardless of stock. This of course is perfectly true within limits—provided the potentialities of that material are already known—though even in our wildest moments we should not plant Cox's Orange Pippin on IX in the hope of making it an orchard standard by proper manurial treatment, or on XII for cordons, relying upon the effects of grass and assiduous root pruning. It is surely reasonable to secure the control over performance obtainable by rootstock selection at the outset, and afterwards to superimpose the influence of manurial and cultural treatments.

The pomological survey of the established bush plantations on the Lower Greensand in Kent revealed that the most common form of "Paradise" was a mixture of Nos. II, III, IV and V. After all that is now known of the different responses of the same variety upon these different stocks, the task of tuning up 100 per cent. of this mixed population to optimum health and productivity is indeed well nigh hopeless. Again, it should be remembered that only a few years ago the vast majority of imported Paradise rootstocks from the Continent was the so-called Improved Doucin (V), so easy to propagate and work, yet under so many conditions the scion varieties grown thereon are so outstandingly difficult to build up into trees of first rate production. To-day that stock has been replaced, in this country at least, by the true Doucin (II) and Broadleaf (I), two good rootstocks of which there should now be an adequate supply and about which much information is now available. We have, in addition, a sufficiency of Nos. IX and XVI or XII for more specialized requirements, and, except for the missing link, the ideal semi-dwarf, it would appear that we can now very generally afford to ignore—and should often definitely shun—the rest of the embarrassing choice which was in the field twenty-one years ago. Should you be drawn into "the Crab" controversy, I would merely remind you that each one of these rootstocks is an individual with its own singular influence, the reaction of which to any one management factor is entirely unknown. "The Crab" in fact can only be better or worse as its "divine average" approximates to stocks of good or bad performance. Don't forget that "the Paradise" stocks were similar in their seedling origin—both as wildings and from the cider press; many of them undoubtedly masqueraded then as Crabs, and some indeed give admirable standardized Standard trees of known potentialities to-day. The two previous papers on soils and manures have been particularly valuable as illustrating the interdependence of all the complex factors, to which one of East Malling's contributions has been the realization of the differential behaviour of trees upon different standardized rootstocks.

And as to the practical aspect? Last year East Malling received applications for 1,200,000 standardized rootstocks. It actually supplied 300,000 and over 1,000,000 have been distributed in the past five years. In addition you have only to study your Tree Planting Number of the *Fruit-Grower* journal to see how many large commercial nurseries have become self-sufficing in the matter of standardized rootstocks—*and the nurseryman grows what the fruitgrower demands.*

PRESENT DAY STRAWBERRY PROBLEMS AT EAST MALLING

By R. V. HARRIS, A. M. MASSEE, W. S. ROGERS AND I. LAUDER-THOMSON

Cultivation.

Experience has shown that the success or failure of a strawberry field under our conditions is largely decided in the runner bed and in the first year of the life of the plantation.

Strains.

The situation with regard to different strains of the same variety is still rather complicated. Differences between strains are certainly found, but they appear to consist chiefly of differences in the amount of disease present, which may possibly be due to differing resistance to diseases and pests. The importance of planting only perfectly healthy virus-free stock is very evident.

Choice of Runners.

Experiments in which all of the runners, from the first to the hundredth (or over) formed by single parents, have been individually recorded show that *once they are established* all the healthy runners have equal chances. The first and earliest runners are naturally the largest when planted, but later formed runners catch them up in the first year, and finally crop just as well. The very small runners are, however, more liable to damage by warm water treatment and by unfavourable conditions following planting.

Time of Planting. The essentials are sufficient warmth and sufficient moisture for good root growth, given these conditions, the earlier the better. Under Kent conditions September and October give best results. Unfortunately the warm water treatment tends to check new root growth for a period of about three weeks, hence if planting cannot be carried out by October, it is better to wait till spring. Choice of best time of planting resulted in an extra ton of fruit per acre in four years' crop.

Deblossoming. Usually it pays to remove the blossom in the first year. The increase in crop the following year more than makes up for the loss of the first year's crop, without counting the saving in strawing.

Runner Production. Various methods of planting for runner production are possible. The wider the parent plants are spaced, the more runners they produce. Close planting gives most runners per acre, however. A good compromise for virus-free beds is to plant 3 feet square, and lay the runners into alternate squares, cultivating both ways.

Plants allowed to form runners in their first year bear only half a crop the second year. Early planting and deblossoming are especially well worth while for runner production.

Diseases and Pests.

Virus (*Yellow-edge Disease*). It would appear from our experiments that once a strawberry plant is infected with the virus disease known as Yellow-edge, that plant and all its runners are doomed. What is worse, yellow-edge plants are deadly to their neighbours and must therefore be removed from the runner beds and from the fruiting plantation. Infection of a plant with the yellow-edge virus results in the production of dwarfed curled leaves with yellow margins and shortened stalks which give the whole plant a flattened instead of the normal " domed " appearance.* Unfortunately these dwarf yellow-edge leaves are not produced continuously throughout the season.

Thus in three of the four consecutive seasons (1931-34) in which detailed observations have been made at East Malling on the symptoms shown by Royal Sovereign, only a small proportion of virus-infected plants developed the characteristic symptoms in the early part of the season (May and June)† and any approach to a critical distinction between normal and virus-infected plants was not possible until the latter end of the season, i.e. from mid-September till late October. On the other hand, in the persistently hot, dry season of 1933, characteristic yellow-edge plants were commonly observed in late May and in June, but later a general suppression of symptoms took place which persisted throughout the remainder of the growing season.

It is clear from this broad summary of observations that irregularity in the manifestation of symptoms is related to seasonal changes in climate, and work is in progress to determine the crucial factors concerned and also to facilitate diagnosis during periods of partial symptom suppression. Meanwhile the elimination of virus-infection from runner beds can only be effected by a *series* of inspections and " roguings " starting at the beginning of each growing season and culminating in the period immediately preceding autumnal leaf discoloration (i.e. from mid-September to late October or early November).

Aphis (*Capitophorus fragariae* Theo.). The strawberry aphis which has long been known as an enemy to the strawberry, has now been proved to be an additional menace as a carrier of the yellow-edge virus from diseased to healthy plants. In our experiments plants originally healthy, to which aphids have been deliberately transferred from a yellow-edge plant, have become infected with yellow-edge disease, whilst plants also originally healthy to which aphids were deliberately transferred from a healthy plant, were found to remain healthy. In the course of this experiment precautions were taken to see that all the plants were kept free from other insect pests which might have been virus " carriers ", by repeated applications of lime-sulphur and nicotine right up to the time of the initial inoculations with the aphis.

Mite (*Tarsonemus fragariae* Zimm.). The tarsonemid mite is well known for the serious damage which it does to strawberry plants in dry seasons. Unfortunately this damage not only impairs the health of the plant but it also makes accurate recognition of yellow-edge plants impossible by masking the symptoms. Whilst there appears some reason for concluding that the aphis is of more importance than the mite as a carrier of the virus, we are still faced with the vital necessity of controlling the mite in order to be able accurately to recognize and destroy the yellow-edge plants.

* A detailed account of these symptoms with photographic illustrations has appeared in the *Journal of Pomology and Horticultural Science*, Vol. XI, pp. 56-76, under the title " The Strawberry ' Yellow-Edge ' Disease ".

† In 1934 no yellow-edge symptoms were observed at East Malling until early August.

Warm Water Treatment.

This brings us to the control method for freeing strawberry runners from an infestation of the Tarsonemid mite and other pests. The warm water treatment which consists of total immersion of the runners in water at a constant temperature of 110° F. for twenty minutes, has already been described in detail so it will be sufficient here to stress a few important points which must be borne in mind if success is to be obtained.

1. An accurate thermometer must be used, and the water must be kept stirred.

2. The plants must be plunged loosely, and not in tied up bundles in which runners are usually collected.

3. If possible the plants should be put inside a container to prevent them from touching the sides or the bottom of the tank, since this is one of the chief causes of overheating. A wooden rack should be fitted to the bottom of the tank.

4. To guard against overheating, the runners should be plunged into cold water directly after treatment.

5. The warm water treatment checks root development (especially in the case of small or weak plants), so that runners should be treated and planted only when the weather conditions are favourable to new growth. The risky period in Kent extends from the end of October until March.

In Kent this method has been adopted as a commercial proposition and has proved quite satisfactory when properly carried out.

In Kent a number of commercial growers have treated their plants successfully by means of the galvanized tank, which is placed in the soil, leaving sufficient space for the fire underneath it, and building up a chimney at one end. A suitable site for the tank is the side of a hill or bank. The fire should run the whole length of the tank, in a manner similar to that adopted by hop growers for steeping hop poles in a creosote tank. The water in the tank should be heated to 112° F. This is two degrees above the required temperature, but as soon as the runners are placed in the water, the temperature drops about 3°—to 109° F. The temperature should be raised again as soon as possible by stoking the fire under the tank. In practice it has been found convenient to place the runners in cauliflower nets for convenience of handling.

The grower who is going to treat runners in this way for the first time would be well advised to test the home made apparatus by using turnip tops or other greenstuff (instead of strawberry runners) to determine whether the desired temperature can be maintained.

Special apparatus, controlled by a thermostat, similar to that used by bulb growers is available on the market, but the tank method described above is efficient provided a good thermometer is used and the correct water temperature is maintained.

Root Rot.

An examination of certain virus-free plants showing a rotting of the root-system led to the isolation of certain fungi which have been shown to be capable of causing injury to the roots of strawberry plants when grown under certain artificial conditions in pots. The relative parts played by these fungi and by the soil in the inducement of an epidemic attack under ordinary plantation conditions is being studied with a view to arriving at effective control by some form of soil treatment.

MYCOLOGY

THE DEVELOPMENT OF SCAB IN STORED APPLES

By H. WORMALD

COMPARATIVELY little attention has been given to the appearance of apple Scab on the fruit during the storage period, although in recent years some interest in this phase of the disease has been roused in America and on the Continent.

Scab spots that develop on apples during storage are so unlike the ordinary Scab lesions that they may easily be mistaken for some form of " functional " spotting ; it is therefore desirable that the grower should be able to recognize this form of the disease.

Instances of severe storage Scab came to the notice of the writer during last Winter. In the middle of February (1934), a grower brought to the East Malling Research Station a Bismarck apple very badly spotted. The spots were of three types, viz. (*a*) saucer-shaped, shiny, jet-black depressions with their margins fairly sharply defined ; (*b*) superficial dark brown spots showing lobed growth, with irregular margins and (*c*) very small dot-like " pin-head " spots just visible to the naked eye. When examined with a lens some of the sunken spots were seen to bear definite raised pustules that proved to be conidial fructifications of the Scab fungus (*Venturia inaequalis*).

The largest individual spots were about one-eighth of an inch in diameter, but in places they were so numerous that they became confluent, forming large sunken blackened areas up to three-quarters of an inch in diameter (Fig. 1). As in such areas the individual spots were ill-defined, they could not be accurately counted, but it was estimated that on this particular apple there were altogether over 400 infection spots. There were no spots such as are often seen on apples when put into store, so that it would seem that all the spots on this specimen had actually become visible only during storage.

The grower was asked for further samples and towards the end of the month other apples from the same batch were received. These showed the same kind of spotting ; they were not so severely affected as the first specimen, but in addition to the three types of spotting mentioned above they bore a few Scab spots of the ordinary type, similar to those commonly seen on marketed apples. These ordinary Scab spots were brown or greyish, with a dark margin and a corky surface. The grower stated that the apples had been " picked in misty weather and came in slightly damp. They were graded after about a week to National Mark Fancy Grade and stored in orchard boxes in a brick building on a clay floor." He also said that this infection was not found on Bramley's Seedling or any other variety stored under the same conditions.

Scabbed Bismarck apples, obtained for comparison from a private house where they had been stored in the cellar, were very different in appearance. The Scab spots were larger (up to half-an-inch in diameter) and corky, many with small cracks, brown, with a darker marginal zone, and they were not definitely concave and saucer-shaped as

* Reprinted from the *Journal of the Ministry of Agriculture*, 1934, Vol. 41, 551-6, by permission of the Editor and the Controller of H.M. Stationery Office.

in the larger storage Scab spots. These were evidently the original spots that were present when the apples were picked, and there was no reason to suppose that, in this case, any of the spots had arisen after the fruit had been stored; there were no pustules or spores on these spots, which were apparently quite barren.

Early in March another batch of Bismarck apples, also showing storage Scab, was received from another locality. Again the spots were mostly jet-black, saucer-shaped and very numerous; on the whole, they were larger than those of the specimens examined earlier, many of them being about one-fifth of an inch in diameter. They were confluent in places, forming large irregular black areas, and sometimes they were in series, forming lines; on one apple there was a continuous line of spots, one and a half inches long, besides shorter lines and many scattered spots (Fig. 3). At the stalk end of the same apple were numerous very small spots consisting of branched (dendritic) lines, forming a kind of close network. Fig. 4 shows this condition as seen with a hand-lens. The larger spots again were concave and bore Scab pustules. The grower said that Newton Wonder and Bramley's Seedling apples stored in boxes near the Bismarcks were not affected.

The occurrence of spots in series suggests that spores had been carried and deposited by something moving in lines; there are two possible explanations: (*a*) that spores were carried in drops of water flowing over the surface, or (*b*) that they were carried by crawling insects.

A microscopic examination of the sunken spots showed that there was in each a thin pad consisting of fungal cells beneath the cuticle. On some of the spots it was seen that from this pad the fungus had developed cushion-like out-growths that burst through the cuticle, appearing at the surface as pustules. These pustules had the dense (stromatic) structure associated with those Scab fungus fructifications that often develop on apple twigs, and at the surface they bore slipper-shaped spores that were recognized as belonging to the *Fusicladium* stage of the apple scab fungus *Venturia inaequalis*.

There was no doubt therefore that these circular, jet-black, sunken spots were Scab lesions, although they were so different, in general appearance, from the spots so common on the young and on the maturing fruit on the tree.

No spores were seen on the smaller, more superficial, lobed spots, but these, too, were shown to be undoubted Scab spots by transferring particles from them to culture plates. These particles grew out and produced fungal cultures which developed *Fusicladium* spores, thus confirming their identity with the Scab fungus.

It is evident, therefore, that the type of injury here described is a result of infection by the Scab fungus, and that such spotting appears after the fruit is picked. It will be obvious, too, that an apple such as that shown in Fig. 1, if of "Fancy" grade when stored, must have been free or almost free from visible spotting.

Whether storage spotting arises from infection during the storage period, or whether it results from previous infection, invisible at the time of fruit picking, but after an "incubation" period producing visible spotting, is a debatable subject, and evidence has been brought forward by different observers in support of each point of view.

It may well be that such severe infection as is here described arises primarily from infection before storage, but followed later by further infection that occurs during the storage period. From the condition of the apples shown in the accompanying illustrations, it is almost incredible that the amount of infection present could have been initiated while the fruit was still on the trees. The spots were found in all stages of development, from minute specks to spots one-fifth of an inch across, as late as the beginning of March. Some of the larger (presumably the older) spots produced pustules during storage, and it is possible that spores liberated from the pustules were responsible for the infection seen as "lobed" spots, or for the minute "pin-head" spots. It is evident that the apples

had been stored under conditions particularly favourable for the development of the Scab fungus, and the variety Bismarck is known to be very susceptible to Scab infection. However, there appears to be no experimental evidence that Scab infection can start under storage conditions, and Miss K. H. Johnstone, working at Long Ashton, obtained no success in attempts to infect storage apples with spores of the Scab fungus (6).

Observers in America and on the Continent have demonstrated that Scab lesions may appear during storage ; and it is certain that the lesions are, in many cases, the result of infection that has taken place before the fruit is picked. Folsom (4), in America, found " that the storage form of Scab could be apparent to the camera at packing time while not evident to the naked eye." Wiesmann (10), in Germany, saw storage Scab spots by means of the microscope while they were still invisible to the naked eye. He marked some of these spots and found that after the fruit had been stored ten weeks the spots had become 0·5 cm. in diameter.

During the last five years storage Scab appears to have been prevalent in certain districts on the Continent, viz. in Germany, Austria, Russia, and Switzerland. Fischer (3) mentions its frequent occurrence in Austria in recent years. Laubert (7), in Germany distinguishes storage Scab from ordinary summer Scab, and from autumn Scab (when the disease appears suddenly on hitherto sound fruit) by the sunken pitch-black shining spots. Other German observers who have written on storage Scab are Rothe (9), Loewel (8), and Frickhinger (5).

Interesting observations were recently made by Faes and Staehelin (1) in Switzerland. They carried out experiments in which apples were stored when apparently quite sound, on 16th November. In one series, apples in ordinary storage showed 71 per cent. scabbed on 6th February. In a corresponding series the apples were wrapped in oiled paper, but again 69 per cent. became scabbed by February. They also obtained data (2) showing that the fruit from trees that had been sprayed with Bordeaux mixture contracted less Scab in storage than the fruit from trees sprayed with lime-sulphur.

For the control of storage Scab, a late spray is generally recommended. Growers usually try to avoid late spraying because of the deposit that may remain on the fruit at picking time. The three or four ordinary routine applications of Bordeaux mixture or lime-sulphur should generally be sufficient to keep scab within reasonable control throughout the season ; but during a wet Summer, or when the earlier sprayings have not provided adequate protection, a late application of colloidal sulphur or a sulphur dust would tend to minimize late infection.

Picking and storing apples during rainy weather should be avoided. If it is necessary to pick apples while they are wet, the surface moisture should be allowed to evaporate before the fruit is finally boxed.

Summary.

Scab spots may appear during storage on apples that are apparently quite sound at the time they are picked.

These storage Scab spots are different from the ordinary Scab spots seen on fruit before storage, in their absence of cork, and in the sunken, saucer-shaped form and shiny black colour of the larger spots ; the smaller spots are more superficial and usually lobed.

The larger spots may produce pustules bearing spores.

To avoid storage Scab routine spraying must be a regular practice, and if necessary a late application of a fungicide must be made. Apples should not be stored when they are wet.

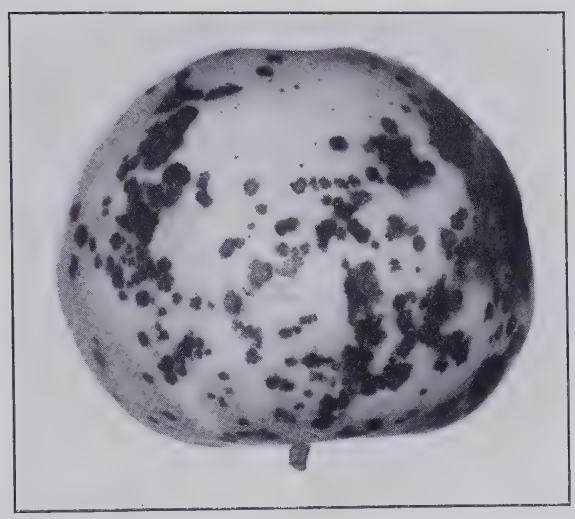

FIG. 1.

Bismarck apple with very severe storage Scab. Taken from store in the middle of February.

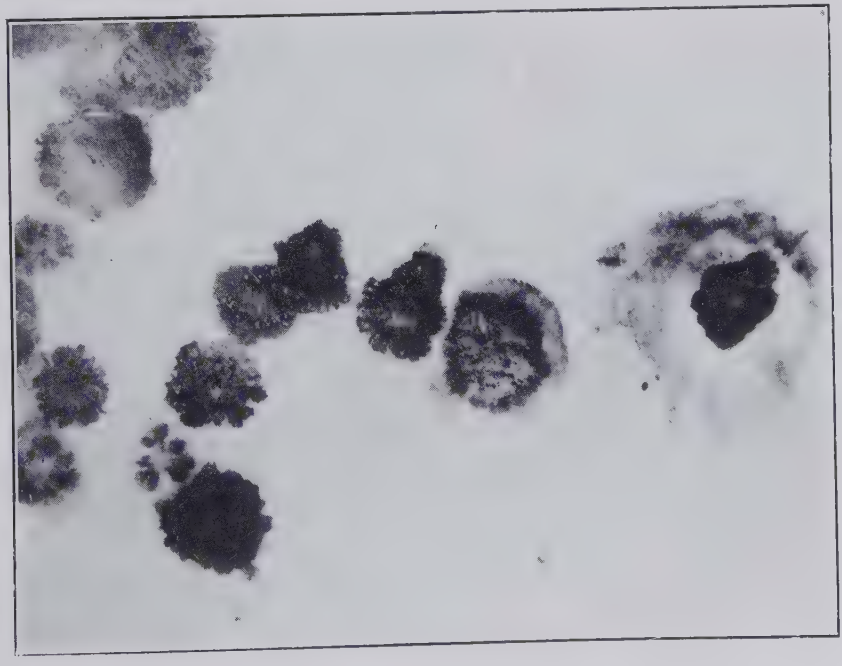

FIG. 2.

A portion of the apple in Fig. 1, as seen with a pocket lens (×6), showing the larger spots with pustules.

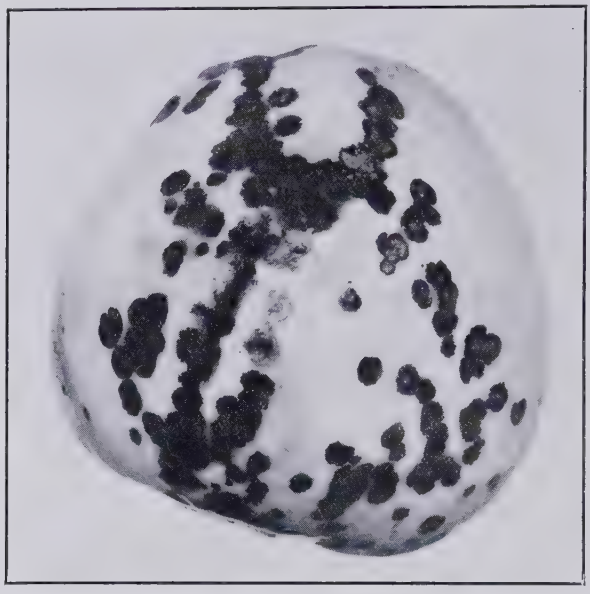

FIG. 3.
A Bismarck apple with storage Scab. Taken from storage early in March.

FIG. 4.
Portion of the stalk end of the apple in Fig. 3, as seen with a lens (×6), showing numerous small lesions forming an irregular network.

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ENTOMOLOGY

OBSERVATIONS ON WOOLLY APHIS *(ERIOSOMA LANIGERUM* (HAUSM.)) IN 1934

By R. M. GREENSLADE

Woolly Aphis or American Blight was again present in large numbers at East Malling in 1934, though the pest was not quite so serious as in 1933.

Notes on the Life History.

During the winter, 1933-4, aphides were present on all parts of the trees. Adult aphides were present at first, but by February it was difficult to find any but first stage nymphs. These began to be active and produce the characteristic white " wool " about the middle of April and most were adult at the beginning of June. A few newly-born nymphs were noted at this time and by the middle of June they were breeding freely.

Eggs.

Woolly Aphis eggs were commonly found in December under the masses of " wool " and cast skins left by the aphides. They were also obtained in the laboratory by keeping the winged forms in small cells to produce the sexual forms which pair and produce the egg.

Migration.

Migration was observed in July in dry weather. First stage Woolly Aphis nymphs were walking in all directions on the trees, and one or two could be found on almost every stone or lump of earth beneath the trees. This migration of the young Woolly Aphis was noted by De Fluiter in Holland (1). The grease bands on the trees were thick with aphides, both at the top and bottom edges, which indicates that migration was taking place in all directions and not down to the roots or trunk. This migration of the young active stages of Woolly Aphis is possibly one explanation of the great increase of the species in dry summers, since wet ground would almost stop migration. At the same time it was noted that in badly infested trees the young nymphs could be found in the loose hanging masses of " wool " and were carried about in it by the wind. Several greased glass plates were therefore hung at various heights amongst the trees during a windy period and a large number of aphides, all first stage nymphs, were caught. This is evidently another method of spreading from tree to tree when the infestation is bad.

Sudden Disappearance of Attack.

In the last half of August and beginning of September there was an almost complete disappearance of Woolly Aphis from an orchard which was previously very heavily infested. This was most noticeable on a block of trees which had not been sprayed at all

during the year. Careful search failed to reveal the presence of any unusual number of predaceous insects and no parasites were present. The rest of the field had been sprayed with the usual routine sprays and, on 23rd July, with soap and nicotine against Woolly Aphis. On this part of the field the infestation was reduced after spraying, but the insects were still present in some numbers. It was noticed that the leaves protected many colonies of aphis from the spray and that those which were not directly hit by the spray were not wetted. The reduction of numbers in August affected the whole field, but was more noticeable on the unsprayed trees, which suggests that climatic conditions reduced the whole infestation and that the number of predators left on the unsprayed trees, though not abnormal, was sufficient to clear up the remainder of the aphis on those trees. This decrease of infestation has also been noted by Rosenberg (2) during his experiments on the colonization of *Aphelinus mali*. He writes : " On 31st August (1933) it was noticeable that there had been a marked decrease in Aphid infestation, especially on colonized trees." Since this occurred also on trees not colonized by *Aphelinus*, it was probably due to the same reason as the decrease this year at East Malling. Even within this district the sudden decrease was not general.

Existence Below Ground.

Observations on an attack of Woolly Aphis in a stool bed showed that as the stocks were earthed up during the summer the aphides continued to live below the soil and were present in large numbers when the stocks were cut out in December. This demonstrates the possibility of the aphis living below ground, although in this district root infestation has not been observed.

Control by Hand Painting.

A serious infestation of Woolly Aphis occurred on some Bramley's Seedlings about twenty years old, top-grafted by the so-called " porcupine " method and by other methods. The former in particular were badly attacked at the pruning wounds and it was decided to use the hand painting method reported by Dennys (3) in Canada. The cankers and wounds on the trees so treated in July have remained free of aphis up to the time of writing (January, 1935), although it is still present on the parts of the same trees left as controls. No damage was done to old wood and none could be seen on green wood. The leaves, however, if they came into contact with the mixture, turned yellow and dropped. The effect on next year's buds is not yet known, but for use on cankers and wounds on the old bark the method is obviously of value. It has been tested for four years in Canada.

The paint consists of :

Castor machine oil (heavy grade) ..	1 quart.
Water	3 quarts.
Nicotine (95 to 98 per cent. purity)	1 fl. oz.
Flour	½ lb.

The flour and water are boiled to a paste and the nicotine added. Then the oil is stirred in and the whole shaken in a closed container until a smooth creamy emulsion is formed. This is applied with a stiff brush. The oil used, Shell Castor Machine oil No. 1173 (a heavy mineral oil with a proportion of special soap) is obtainable commercially. A gallon of mixture (1 quart of oil) was sufficient to treat thirty trees grafted by the " porcupine " method, on which there were an exceptional number of infested pruning wounds.

Summary.

1. At East Malling in 1934 Woolly Aphis began to be active by the middle of April and were breeding by the middle of June.

2. Migration of the young active first stage nymphs was observed to take place by two methods : by walking or falling to the ground and walking to neighbouring trees and by being blown about in loose masses of " wool ". The first method seems the more important.

3. During August a heavy infestation of Woolly Aphis almost disappeared. The reason was probably climatic as predaceous insects were not very common, but that they played some part is indicated by the fact that infestation was actually much more reduced on unsprayed trees than on those which had been sprayed.

4. Aphis present in stool beds were found to go on living under ground as the stocks were earthed up.

5. The occurrence of Woolly Aphis eggs is noticed.

6. A hand painting control method, already published by another worker, was found effective at East Malling.

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GENERAL

THE FUTURE OF WALNUT PROPAGATION IN ENGLAND*

By J. B. HAMOND

Introduction.

Good walnuts have always been very popular in England, and walnut trees are to be found scattered all over the country. The vast majority of these fine old trees have been grown from nuts, many of them sown over five hundred years ago, and although adding to the beauty of the countryside, they are often almost useless when considered from the point of view of fruit production. The nuts are frequently small and dark coloured, containing an unattractive looking kernel with an insipid or sugary flavour, different indeed from the large, fully-flavoured nuts of good, named varieties which are sent over here from France, America, and Italy. This state of things caused the late Mr. Howard Spence, of Southport, to suggest that something might be done to improve the quality of the walnuts produced in England, by raising grafted trees of approved varieties. He sought the co-operation of East Malling Research Station, and the work has been carried on here during the last few years.

Selection of Varieties.

In order to discover first-class English walnut trees from which to propagate, the Royal Horticultural Society assisted by the Ministry of Agriculture, held a most successful Walnut Competition in 1929. At this Competition over 700 entries were received and as a result, five trees were selected for rapid propagation in this country. In addition to selecting trees known to bear good, edible nuts, two walnut trees were chosen which always bear their nuts in large grape-like clusters.

Samples of these small nuts have been tested by two well-known firms and found to be especially suitable for pickling. Having selected these seven English walnut trees for further propagation, good named foreign varieties were then investigated with a view to finding a few which would grow well in this climate. Material was collected from America, France, Belgium, Italy and the East, including some sixty-four varieties in all. Many of these, particularly some from California, India and China, proved to be of very little use in this country on account of early leafing-out and subsequent injury by our late spring frosts. Others were very susceptible to disease. After making observations in the nursery for several years, four French varieties, Franquette, Mayette, Meylanaise and Treyve, and one American variety, Woodland, were chosen for extensive propagation in this country. All these varieties leaf-out late in spring, and are known to bear nuts of excellent quality. The American variety Woodland is interesting, as it bears catkins as well as nutlets during the first few years. Most grafted trees bear only nutlets during the first five years, and they mature only if they are fertilized by pollen from an

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older tree. After this time both types of flower are usually borne on grafted walnut trees. Seedlings are reputed to come into cropping considerably later. On account of its precocity in bearing catkins, the variety Woodland should bring about early cropping if planted up with other young walnut trees. Since 1932, walnut propagation at this Station has been almost entirely restricted to these twelve selected varieties, which are suitable to English conditions. The other varieties have been retained in two complete variety collections where they will be available if required to build up a stock in the future.

PROPAGATION.

Experiments in methods of propagation have been carried out under the direction of Mr. A. W. Witt ; at present the results of grafting and budding outdoors are very irregular owing to our variable climatic conditions, so a successful method of raising the trees under glass at a low cost has now been evolved.

Seedling rootstocks of *Juglans nigra* are at present used for most of the walnut grafting, but there is reason to believe that *Juglans regia* seedlings, which are more readily obtainable in this country, will prove equally successful, and some of these were tried out successfully in 1934. The nuts are stratified in sand during the winter, and sown in nursery rows during the following March. In November the resulting seedlings are lifted, potted into $4\frac{1}{2}$ inch pots, with the crown of the tap root well exposed, and kept in a cool greenhouse until February, when they are moved into the propagation house preparatory to grafting.

During the winter, scion wood is cut from selected trees. It is important to obtain solid, well-ripened shoots for this purpose, as thin pieces, with a high proportion of pith to wood, form very little callus tissue. The graftwood is cut into convenient lengths, and the cut surfaces are covered with grafting-wax. The wood is then stored in moist sphagnum moss until required for use. Before grafting, the stocks are cut off about three inches above soil level and the scion is actually inserted at the top of the tap root, a double whip and tongue graft being used. After tying, the union is waxed and the pots are plunged in coconut fibre refuse in a closed frame, with a bottom heat of about 60° F. A union takes place, although more slowly if the pots are left on the open bench. After about three weeks the grafted walnuts are removed from the closed frames. In normal cases a union will have taken place during this time, and new growth will have appeared. Using first-class material, 90 per cent. success was obtained by this method in 1933. During the early summer the plants are hardened off on the bench, where they are exposed to plenty of light and air. They grow quickly, and frequently make 1 to 2 feet of strong new growth by the beginning of June. They are planted out in the nursery during the summer. During the next year or two, the tips of the side shoots are pinched off in the growing season and the trees are run up to a single, straight stem. When they are about 5 feet high they are transplanted to permanent positions.

Walnut grafting may also be carried out in the summer using herbaceous scions. The same method is adopted, but a union place takes more quickly at this time of the year.

Although seedling rootstocks are at present used for most of the walnut grafting, some vegetatively raised rootstocks are being used on an experimental scale, in case the seedling roots should ultimately give variable tree performance.

Walnuts do not root freely from cuttings or layers, but several selections of *Juglans* species are being tried out, and in November, 1933, 235 rooted layers were cut off and planted. This figure represents an encouraging increase on any previously obtained, and indicates that there is reason to expect better rooting as the stools become older and the vigour of the annual shoots is reduced.

Distribution of Trees.

During the last four years the demand for grafted walnut trees has increased steadily, since it has become known that these trees are now being more readily raised in this country. In the autumn of 1931 most of the trees available were distributed in experimental sets, each set consisting of the same twelve varieties. Six of these comparable sets were planted up in a belt across the South of England. These varieties were also included in the complete collections placed at East Malling, and at Mr. Spence's farm in Sussex. It has thus been possible to make observations on the same twelve varieties growing under eight different soil and climatic conditions, namely, in three places in Kent, in Sussex, Essex, Suffolk, Wiltshire and Somerset.

In 1932 a larger number of grafted trees were available and a ready demand was found for them. In addition to supplying growers in this country, trees were sent to Australia, South Africa, Denmark and Palestine. Scion-wood of certain varieties that do well under Californian conditions is now being produced here, and from this material it will be possible to raise trees suitable for growing in warmer climates, which will meet the demand from the Dominions and elsewhere. In all, some 142 grafted walnut trees were distributed from this Station in 1932.

After the hot summer of 1933, which was almost ideal for walnut growing in this country, there was a widespread interest in the walnut work at this Station. Over 270 trees were distributed and the supply did not by any means meet the demand.

Since the production of grafted walnut trees on a commercial scale has become a practical proposition, and an apparently constant demand at a remunerative figure aroused, it was suggested that the Trade should be invited to undertake this side of the work. This suggestion was well received and a well attended demonstration in walnut grafting was held at East Malling in the spring of 1934, and four nursery firms were supplied with young grafted walnut trees of approved varieties in the autumn of the same year. From this nucleus of material, it is hoped that these firms will be able to build up a stock from which to obtain scion-wood, and thus to meet the demand for grafted walnut trees in England and elsewhere.

The Kent Incorporated Society for Promoting Experiments in Horticulture

THE RESEARCH STATION
EAST MALLING, KENT

ALPHABETICAL LIST OF MEMBERS

ALPHABETICAL LIST OF MEMBERS

ABBREVIATIONS:—

Fo. =Life Founder.
A.Fo. =Annual Founder.
Fe. =Life Fellow.
A.Fe. =Annual Fellow.
A. =Life Associate.
A.A. =Annual Associate.

The names of deceased Life Founder Members are included and marked *.

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A.A.	Burgmer, H. ...	Straelen-Niederrhein, Germany.
A.A.	Burnett, Dr. F. Marsden ...	34 High Street, Sevenoaks, Kent.
A.A.	Burney, Com. A. B., R.N.	The Freight, Cranbrook, Kent.
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A.Fe.	Cassel Hospital, The ...	The Swaylands, Penshurst, Kent.
A.	Castle, W. H. ...	East Dene, Pean Hill, Whitstable, Kent.
A.A.	Chalcraft, Mrs. N. ...	West Court, Binsted, Alton, Hants.
A.	Chambers, A. E. ...	Fairlawn, Maidstone, Kent.
Fo.	Chambers, E. H. ...	East Hall, Boughton Monchelsea, near Maidstone, Kent.
A.A.	Chambers, Rev. F. ...	Lested Lodge, Chart Sutton, Kent.
Fe.	Chambers, H. G. ...	The Hollies, Otham, near Maidstone, Kent
Fo.	Chambers, P. ...	Shepway Court, Maidstone, Kent.
Fo.	Chambers, W. & Sons ...	Manor House, Southfleet, Gravesend, Kent.
Fo.	Champion, B. ...	Baron's Place, Mereworth, Kent.
Fe.	Champion, B. A., F.S.I. ...	13b Lowfield Street, Dartford, Kent.
A.A.	Champneys, H. O. ...	The Grange, Lamberhurst, Kent.
A.A.	Chance & Hunt, Ltd. ...	5/7 St. Helens Place, London, E.C.3.
A.A.	Chandler, A. S. ...	c/o Messrs. W. O. Chandler & Son, Goldstone, Ash, Canterbury, Kent.
A.Fe.	Chandler, W. O. & Son ...	Goldstone, Ash, Canterbury, Kent.
A.A.	Chaplin, T. G. ...	Home Farm, St. Paul's Cray, Kent.
A.A.	Charing Gardeners' Society	Cradwells, Charing, Kent.
A.A.	Charlton, F. R. ...	Ledian Farm, Leeds, near Maidstone, Kent.
A.A.	Charlton, G. E. ...	Glebe Farm House, Leybourne, Kent.
A.A.	Charsley, R. H. ...	Magazine Fruit Farm, Park Road, Colchester, Essex.
A.A.	Chatto, A. E. ...	White Barn Farm, Elmstead, Colchester, Essex.
Fo.	Chaytor, A. D. ...	Leases Hall, Leamington Bar, Northallerton, Yorks.
A.A.	Cheeseman, Mrs. C. ...	Tilsden, Cranbrook, Kent.
A.A.	Cheesman, F. P. ...	Beresford House, Sutton Valence, Kent.
A.A.	Cheesman, Miss M. ...	119 Chaldon Road, Caterham, Surrey.
Fe.	Cheetham, Capt. C. E. ...	Poplar Hall, Faversham, Kent.

Fo.	Chivers & Sons, Ltd. ...	Histon, Cambridge.
A.A.	Christie, H. W. ...	52 The Drive, Tonbridge, Kent.
A.A.	Church, L. A. King- ...	New Holme, Bratton, near Westbury, Wilts.
Fe.	Clark, G. & A., Ltd. ...	The Nurseries, Dover, Kent.
	*Clark, G. Foster, J.P. ...	Boughton Mount, Maidstone, Kent.
A.A.	Clark, K. K. ...	Cotley, near Dunsford, Exeter.
Fe.	Clark, W. F. ...	Kenaway, Ospringe, Faversham, Kent.
A.A.	Clark, B. H. Baron ...	Hasketon Hall, Woodbridge, Suffolk.
A.A.	Clarke, D. W. ...	Hartridge House, Cranbrook, Kent.
Fo.	Clarke, J. P. S. ...	(Ashdown & General Land Co.), Broadhurst Manor, Horsted Keynes, Sussex.
A.A.	Clarke, N. ...	Bradford House, Walpole St. Andrew, Wisbech, Cambs.
A.A.	Clarke, P. B. ...	Mathurst Farm, Staplehurst, Kent.
Fe.	Clay, Lt.-Col. Rt. Hon. H. H. Spender-, P.C., C.M.G., M.C., J.P., D.L., M.P. ...	Ford Manor, Lingfield, Surrey.
Fo.	Cobb, Robert, Jnr. ...	Castle Chambers, Rochester, Kent.
Fe.	Cohen, Sir Herbert B., Bart., O.B.E., T.D., M.A. ...	6 King's Bench Walk, Temple, London, E.C.4.
	*Cohen, Lady Louisa ...	Highfield, Shoreham, Kent.
A.A.	Coleman, C. ...	9 South Street, Hucknall, Notts.
A.A.	Coleman, C. F. ...	Broomhill, Hartley, Cranbrook, Kent.
A.A.	Coleman, F. Hinds ...	The Old Parsonage, Goudhurst, Kent.
A.A.	Coleman, J. T. ...	Larchwood Farm, Seal Chart, Sevenoaks, Kent.
A.Fe.	Collard, A. Newman ...	Palmars Farm, Liss, Hants.
Fo.	Collet, Sir Mark, Bart., J.P., D.L. ...	St. Clere, Kemsing, Sevenoaks, Kent.
A.A.	Collier, F. J. ...	Heathfield, St. Saviours, Jersey, Channel Islands.
A.A.	Collier, Lt.-Col. G. A. ...	Hill House, Lawford, Essex.
A.A.	Collins, H. ...	Lindridge Lodge Farm, Lamberhurst, Kent.
A.A.	Collins, J. ...	Little Brook, Marden, Kent.
Fe.	Colombo Commercial Co., Ltd. ...	Thames House, Queen Street Place, London, E.C.4.
A.A.	Colthup, E. G. ...	Howletts, Chilham, Canterbury, Kent.
Fe.	Colthup, E. J. ...	Howletts, Chilham, Canterbury, Kent.
Fo.	Colthup, W. ...	Hopebourne, Harbledown, Canterbury, Kent.
A.A.	Colton Fruit Farm Co. ...	Easton, Norwich, Norfolk.
A.	Cook, Morton L. ...	"Campsie," Shoreham-by-Sea, Sussex.
A.A.	Cook, W. M. ...	3 Howden Road, London, S.E.25.
Fe.	Coombes, F. ...	North Bradley, Trowbridge, Wilts.
Fo.	Cooper, McDougall & Robertson, Ltd. ...	The Chemical Works, Yalding, Kent.
A.A.	Cooper, C. B. ...	"Darley Dene," Addlestone, Surrey.
A.A.	Cooper, C. E. T. ...	The Whangarei Fruit Farms, Ciddy Hall Fruit Farm, Liss, Hants.
A.A.	Cooper, G. V. ...	Forge House, Grange, Gillingham, Kent.
A.	Cooper, H. E. W. ...	Pot Kiln Farm, London Road, Tonbridge, Kent
A.	Corfe & Son, Ltd. ...	Agricultural Chemists, 5 Gabriel's Hill, Maidstone, Kent.
Fe.	Corfe, A. A. ...	Court Lodge, West Peckham, Kent.
Fo.	Cornwallis of Linton, The Rt. Hon. Lord, C.B.E., T.D., J.P., D.L. ...	Linton Park, near Maidstone, Kent.
A.	Cornwell, B. ...	"Iona," Gore Court, Tunstall Road, Sittingbourne, Kent.
A.	Cornwell, J. ...	7 Mansfield Road, Ilford, Essex.
A.A.	Cotes, Major Arthur ...	Rowden House, Chippenham, Wilts.
A.A.	Cotterill, G. H. ...	218 Worcester Road, Witton, Droitwich, Worcs.
A.	Courthope, Col. Sir G., Bart., M.P., J.P., D.L., M.C., T.D. ...	Whiligh, near Ticehurst, Sussex.
A.Fe.	Cowburn, A. W. ...	Booths Hall, Knutsford, Cheshire.
A.	Cox, P. W., M.B.E. ...	Sessions House, Maidstone, Kent.
A.A.	Cracknell, Miss C. ...	School of Nature Study and Gardening, Clapham, near Worthing, Sussex.
A.A.	Craig, A. R. ...	Weston-under-Lizard, Shifnal, Salop, Shropshire.
A.Fe.	Craven, W. J. & Co., Ltd. ...	48/50 Port Street, Evesham, Worcs.
Fe.	Crawford, T. ...	Gore House, Upchurch, Sittingbourne, Kent.
A.A.	Crawford, W. ...	Oakleigh, Higham, Kent.
A.A.	Crawter, John ...	The White House, Claygate, Surrey.

A.	Croft, Major O. G. S. ...	Hephill, near Hereford.
A.	Crompton, T. E. ...	Week Green Nurseries, Petersfield, Hants.
A.A.	Cronk, F. G. ...	Cromar, Wateringbury, Kent.
A.A.	Cronk, I. A. ...	New Barns, West Malling, Kent.
A.A.	Crosse, Miss C. H. ...	The Fruit Farm, Beyton, near Bury St. Edmunds, Suffolk.
Fe.	Crowhurst, A. S. ...	Charton Farm, Farningham, Kent.
A.A.	Crundall, J. Wyrock ...	Berechurch Hall Estate Office, near Colchester, Essex.
A.A.	Cuffe, Col. J. A. F., C.M.G., D.S.O. ...	Wyke Mark, Winchester, Hants.
A.A.	Cunningham, Lt.-Col. C. C.	Morning Star, Elgin, South Africa.
A.	Curling, Major J. H. ...	Perry Court, Faversham, Kent.
A.A.	Cutbush, Wm. & Son, Ltd.	The Nurseries, Barnet, Herts.
A.A.	Dahl, C. G. ...	Alnarps Tradgardsskola, Akarp, Sweden.
Fo.	Dalgleish, J. E. ...	The Nurseries, Market Weighton, York.
A.A.	Dan, O. ...	Wateringbury Place, Wateringbury, Kent.
Fe.	Daniels Bros., Ltd. ...	Royal Norfolk Seed Establishment, Royal Arcade, Norwich, Norfolk.
A.A.	Dann, S. ...	Bosbury House, Brenchley, Kent.
A.	Danreuther, W. ...	Battle Fruit Farm, Battle, Sussex.
A.	Darnley, Rt. Hon. Earl of ...	Puckle Hill, Cobham, near Rochester, Kent.
Fo.	Dartford Branch, N.F.U. ...	13b Lowfield Street, Dartford, Kent.
A.Fe.	Davys, Wm. & Sons ...	Cheneys Farm, Thong, Gravesend, Kent.
Fe.	Daw, F. B. ...	Woodlands, Shiplake, Henley-on-Thames, Surrey.
A.A.	Dawson, W. R. ...	Drum, Wych Hill, Woking, Surrey.
Fe.	Day, Alfred ...	Great Tong, Headcorn, Kent.
A.A.	Day, A. J. ...	(Messrs. J. Day & Sons), Paley, Cranbrook, Kent.
A.A.	Day, F. M. ...	Blue House Farm, Marden, Kent.
A.A.	Day, G. M. ...	Barnes Place, Golden Green, Tonbridge, Kent.
Fe.	Day, J. ...	Tutsham Farm, West Farleigh, near Maidstone, Kent.
A.A.	Day, Capt. J. ...	Spitzbrook, Marden, Kent.
A.	Day, Messrs. J. & S. ...	Paris Farm, East Malling, Kent.
A.Fe.	Deacon, J. F. W. ...	Mabledon, Tonbridge, Kent.
Fo.	Dean, G. H. & Co., Ltd. ...	Whitehall Preserve Works, Sittingbourne, Kent.
A.A.	Dean, Vernon ...	Rooting Manor, Little Chart, Kent.
A.Fe.	Dence, A. H. ...	Little Dane, Biddenden, Kent.
A.A.	Denham, Dr. H. J., M.A., D.Sc. ...	Institute of Research in Agricultural Engineering, Parks Road, Oxford.
A.	Dennis, T. G. ...	Dunton Farm, Dunton Green, Kent.
Fo.	Dennis, W. & Sons ...	Kirton, near Boston, Lincs.
A.	Dennis & Cooper ...	Covent Garden Market, London, W.C.2.
A.A.	Dicey, J. ...	Lourensford Estate, Somerset West, Cape Province, South Africa.
A.A.	Dick, Brig.-Gen. R. N., C.M.G., D.S.O. ...	Dee House, Hawkhurst, Kent.
A.	Dickson, A. & Sons ...	Hawlmark, Newtownards, Co. Down, Ireland.
Fe.	Dickson, Lt.-Com. H. H. ...	"Hodnet," Sandringham Road, Catisfield, Hants.
A.A.	Dixon, T.& M. ...	Tardebigge, Bromsgrove, Worcester.
A.A.	Donelly, J. ...	Iona Fruit Farm, Oldtown, Co. Dublin, Ireland.
A.A.	Doubell, W. M. ...	Reynolds, Edenbridge, Kent.
Fo.	Doubleday, L. ...	Hempstead, Sittingbourne, Kent.
A.A.	Douglas, T. B. ...	Stratton, Hatfield Peverel, Essex.
Fo.	Drake & Fletcher, Ltd. ...	Kentish Engineering Works, The Broadway, Maidstone, Kent.
A.	Duckham, A. ...	Rooks Hill, Britchet Green, near Sevenoaks, Kent.
A.A.	Dudley, R. ...	Linkenholt Manor, Andover, Hants.
A.A.	Duffus, A. S. ...	Trevereux Hill, Limpsfield Chart, Oxted, Surrey.
A.A.	Duncan, L. S. ...	Rushbrook Farm, Pluckley, Kent.
A.A.	Dunn, G. S. ...	c/o Messrs. W. O. Chandler & Son, Goldstone, Ash, Canterbury, Kent.
Fo.	Durham, H. E., Sc.D., M.B., B.C., F.R.C.S., A.R.P.S.	Dunelm, Hampton Park, Hereford.
A.	Durling, W. ...	Ightham, Kent.
A.A.	Eagleton, L. O. ...	Bramshott, Liphook, Hants.
A.A.	Earle, A. B. ...	The Old Hall, Puddington, Wirral, Cheshire.
A.A.	East Suffolk County Council	County Hall, Ipswich, Suffolk.
A.A.	Eastwood, J. ...	The Poplars, Horsmonden, Kent.

A.A.	Ebbels, W.P. ...	Southleigh, Stevenage, Herts.
Fe.	Edgecombe, G. R. ...	Whinlatter, Strawberry Hill, Tunbridge Wells, Kent.
A.	Edmonds, J. ...	Hill Farm, Higham, Rochester, Kent.
Fo.	Edmonds, J. & Sons ...	Allington, near Maidstone, Kent.
A.A.	Edmonds, P. ...	Walnut Tree Farm, Grange, Gillingham, Kent.
A.A.	Edmunds, A., C.B., M.B., M.S., B.Sc., F.R.C.S. ...	57 Queen Anne Street, Cavendish Square, London, W.1.
A.A.	Edwards, Capt. C. R. ...	Lower Town, Preston Wynne, near Hereford.
A.A.	Edwards, E. L. ...	32 Greenhill, Evesham, Worcs.
A.A.	Edwards, J. D. ...	The Nook, Hatfield Peverel, Chelmsford, Essex.
A.A.	Egerton, Geoffrey ...	Roadways, Matfield, Kent.
Fe.	Egerton Branch, N.F.U. ...	Court Lodge, Egerton, Kent.
Fe.	Eiloart, F. E. ...	40 Chancery Lane, London, W.C.2.
Fe.	Elgar, W. R. ...	The Limes, Sittingbourne, Kent.
A.A.	Ellis, C. M. ...	Mains of Moy, Forres, Morayshire.
A.A.	Ellis, Oswald ...	Nursecombe, Bramley, Guildford, Surrey.
A.A.	Elms, A. ...	Manor Farm, Bexley, Kent.
Fo.	Elms, F. A. ...	Cragg's Farm, Singlewell, near Gravesend, Kent.
A.A.	Emanuel Barnett, Ltd. ...	522 529 Central Avenue, Covent Garden Market, London, W.C.2.
	*Emmet, T. A. ...	Amberley Castle, Amberley, Sussex.
Fo.	Engelmann, C. G. ...	Carnation Grower, Saffron Walden, Essex.
Fe.	English, O. ...	Manor Farm, Wateringbury, near Maidstone, Kent.
Fe.	English, W. D. ...	Chapter Farm, Rochester, Kent.
A.A.	Erskine, Lt.-Col. K. C. S. ...	c o 2 Eastwood Cottages, Otham, near Maidstone, Kent.
A.Fe.	Esbjerg, Niels ...	Forsogsledor, Forsogsstationen, Blangsted pr. Odense, Denmark.
A.A.	Esbjerg, Niels (The Staff of)	Forsogsstationen, Blangsted pr. Odense, Denmark.
A.Fe.	Essex, Sir R. Walter, J.P. ...	Dixcot, North Drive, Streatham, London, S.W.16.
A.	Everest, W. ...	Crockenhill, Swanley, Kent.
A.A.	Falle, T. de C. ...	39 Parkfield Road, Ickenham, near Uxbridge, Middlesex.
Fe.	Falmouth, The Rt. Hon. Viscount	8 Lennox Gardens, London, S.W.1.
A.A.	Farmar, Major-Gen. G. F. ...	Millwood, Wrotham Heath, Kent.
A.A.	Faure, C. A. Munro- ...	The Knob, Padworth, Surrey.
Fe.	Favell, C. R. ...	Crundall's Fruit Farm, Matfield, Kent.
Fo.	Faulkner, J. J. ...	Sedcott, Fairseat Lane, Wrotham, Kent.
Fo.	Faversham Branch, N.F.U. ...	21 South Road, Faversham, Kent.
A.A.	Fawcett, L. A. ...	Bishopsden Farm, Biddenden, Kent.
A.A.	Fegan's Homes Incorporated ...	Training Farms, Horden, Goudhurst, Kent.
A.Fe.	Fernihough, W. A. ...	Church Farm, Horsmonden, Kent.
A.	Fife, J. ...	West Yaldham, Kemsing, Sevenoaks, Kent.
A.A.	Fillmer, Miss S. ...	Oakfield, Hassocks, Sussex.
A.A.	Finch, A. ...	"Midhope," Kemsing, Kent.
A.A.	Findlay Bros. ...	Springhill Nursery, Baillieston, near Glasgow, Lanarkshire.
A.A.	Finey, C. E. ...	Eden Farm, West Malling, Kent.
A.A.	Finey, C. W. ...	York Farm, Twydall, Gillingham, Kent.
A.A.	Finey, H. ...	Little London Farm, Gillingham, Kent.
A.A.	Finn, G. G. ...	31 Watling Street, Canterbury, Kent.
Fe.	Finn, G. W. & Sons ...	The Mall, Faversham, Kent.
Fo.	Finn, L. H. ...	The Mall, Faversham, Kent.
A.	Finnis, J. T. ...	Collier Street, Marden, Kent.
A.	Fisher, C. ...	Crescent Farm, Sidcup, Kent.
A.A.	Fisher, Miss J. G. ...	Redhill Cottage, Wateringbury, Kent.
A.	Fiske, W. G. ...	Harwood, Corbets Tey, Upminster, Essex.
A.A.	Fleming, Owen ...	Toys Hill, Sevenoaks, Kent.
A.A.	Fletcher, H. A. ...	Chilton House, Aylesbury, Bucks.
A.A.	Fogo, J. Row- ...	Row House, Dunblane, Perthshire.
A.A.	Forbes, Renny & Co., Ltd. ...	Alperton, Wembley, Middlesex.
A.A.	Forester, R. E. ...	Huapai, Auckland, New Zealand.
A.A.	Foster, H. M. ...	Haywoods, Hatfield Peverel, Chelmsford, Essex.
A.A.	Fowle, Mrs. M. B. ...	Costrong Farm, Kirdford, near Billingshurst, Sussex.
A.A.	Fowle, W. ...	Costrong Farm, Kirdford, near Billingshurst, Sussex.
Fo.	Fox, C. M., Ltd. ...	Brook Farm, Marden, Kent.
A.A.	Freeland, G. & Sons ...	Woodside Road, Tonbridge, Kent.
Fe.	Fremlins, Ltd. ...	Pale Ale Brewery, Earl Street, Maidstone, Kent.
A.A.	French, J. Hillier ...	9 King Street, Maidstone, Kent.

A.	French, P. ...	Rose Villa, Teynham, Sittingbourne, Kent.
A.	French, R. S. ...	Hoo Green, Meopham, Gravesend, Kent.
A.	Fromow, W. & Sons ...	Windlesham Nurseries, Surrey.
A.	Furner, W. G. ...	Venner's Farm, Erith, Kent.
A.A.	Gaard, Grefsheim ...	Nes Hedmark, Norway.
A.A.	Gale, A. W. ...	Ivyside, Marlborough, Wilts.
A.A.	Gallimore, A. S. ...	Brewery House, Hatfield Peverel, Essex.
A.A.	Gardner, R. L. ...	The Orchard, Boreham, Chelmsford, Essex.
A.A.	Garnier, Com. H. K., R.N.	Attleborough Lodge, Norfolk.
A.	Garrad, G. H. ...	Brunswick House, Buckland Hill, Maidstone, Kent.
A.A.	Garrard, R. E. ...	P.O. Box 311, Dar es Salaam, Tanganyika, East Africa.
A.A.	Garratt, G. L. ...	Forstal House, Aylesford, Kent.
A.A.	Garraway, Lady ...	Rockshire, Waterford, Ireland.
A.A.	Garrett, T. R. H. ...	Ingoldsby, Longfield, Kent.
Fe.	Gascoyne, E. B. ...	Bapchild Court, Sittingbourne, Kent.
A.Fo.	Gaskain, E. W. ...	Norham House, Selling, Kent.
Fo.	Gaskain, W. F. ...	Dargate House, near Faversham, Kent.
A.A.	Gaskell, W., C.I.E. ...	Hilliers, St. Mary Bourne, Andover, Hants
A.A.	Gates, T. ...	Huggins Hall, Cranbrook, Kent.
A.A.	Gavars, J. ...	M. Bezdelign ieta 5, Riga, Latvia.
A.Fe.	Gay, Lt.-Col. C. H., D.S.O.	Higham Hall, near Rochester, Kent.
A.A.	Gay, G. G. ...	c/o Westminster Bank, Ltd., The Mall, Ealing, London, W.5.
A.A.	Gee, John P. & Sons ...	Denmans Farm, Botley, Oxford.
Fo.	George, The Rt. Hon. David Lloyd, O.M., LL.D., P.C., M.P. ...	Bron-y-de, Churt, Surrey.
A.	George, R. & Son ...	Swan Lane, Evesham, Worcester.
Fe.	Gibson, B. L. ...	East Wickham Farm, Welling, Kent.
A.Fe.	Gibson, E. B. ...	The Cottage, East Wickham, Welling, Kent.
A.A.	Gibson, F. ...	The Cider Orchards, Staplehurst, Kent.
A.A.	Gildert, Wm. ...	30 Ainsbury Road, Beechwood Gardens, Coventry, Warwickshire.
A.A.	Gill, F. Gordon ...	The Old House, High Trees, Reigate, Surrey.
A.A.	Gill, J. Macdonald ...	South Nore, West Wittering, Chichester, Sussex.
A.	Gillespie, D., B.Sc. ...	Barlings, Egerton, Ashford, Kent.
A.A.	Gladstone, J. W. B. ...	The Rectory Farm, Sutton Valence, Kent.
A.A.	Gleed, E. ...	Six Bells Gardens, Westbury-on-Severn, Glos.
A.	Glen, W. ...	Comports Farm, Blundeley Heath, Lingfield, Surrey.
A.A.	Gloster, Lt.-Col. T. H. ...	Elwy, Little Baddow, near Chelmsford, Essex.
A.A.	Glover, D. ...	Flightshott, Brenchley, Kent.
Fe.	Goldsmid, Sir O. E. d'Avigdor, D.L., J.P., M.A., LL.D. ...	Somerhill, Tonbridge, Kent.
A.A.	Goodhew, L. J., Exors. of ...	8 East Street, Sittingbourne, Kent.
A.A.	Goodhew, O. L. ...	8 East Street, Sittingbourne, Kent.
A.A.	Goodson, S. G. ...	Frognall, Wickhambreaux, Canterbury, Kent.
A.	Goodwin, D. G. ...	Elliotts Farm, Penshurst, Kent.
	*Goodwin, E. ...	Canon Court, Wateringbury, Kent.
A.A.	Goodwin, J. G. ...	Fish Hall, Tonbridge, Kent.
Fe.	Goodwin, W. ...	Pauls Farm, Leigh, Tonbridge, Kent.
Fe.	Goodwin, W. Gordon ...	Elliot's Farm, Penshurst, Kent.
A.A.	Gooiland Nurseries ...	(G. Wesseling & Co.), Naarden, Holland.
A.A.	Gordon, L. ...	Stone Hill Farm, Egerton, Kent.
A.A.	Gordon, Col. W. A. ...	Warwick Farm, Mulder's Vlei, Cape Province, South Africa.
A.Fe.	Gore, Miss K. ...	Peacock Hall, Little Cornard, Sudbury, Suffolk.
A.A.	Gough, A. ...	Rectory Lane, Bracknell, Berks.
A.A.	Gracie, A. B. ...	Bigbury House, Harbledown, Canterbury, Kent.
A.A.	Granger, H. ...	The Maldon Fruit and Poultry Farm, Maldon, Essex.
A.A.	Green, L. ...	Cherry Trees, Tardebigge, Bromsgrove, Worcester.
A.A.	Greene, E. ...	Church Farm, Little Wittenham, near Abingdon, Berks.
A.A.	Greenlees, T. ...	Gaysham Farm, Westerham, Kent.
Fe.	Greenlees, W. ...	Woodgate Farm, Borden, near Sittingbourne, Kent.
A.A.	Greens, Messrs. ...	Norfolk Nurseries, Dereham, Norfolk.
Fo.	Greenwell, Sir Bernard E., Bart., M.B.E. ...	Marden Park, Woldingham, Surrey.
A.A.	Greg, A. C. ...	Ash House, Acton Bridge, Northwich, Cheshire.

A.A.	Grey, The Rt. Hon. Countess Mabel	...	Howick, Alnwick, Northumberland.
A.	Gribble, T.	...	Sutherland, Sutherland Avenue, Bexhill-on-Sea, Sussex.
A.A.	Griffith, H. M.	...	(Wargundy Orchards, Ltd.), Westminster, Orange Free State, South Africa.
A.A.	Groom, H. C. & Co.	...	Bellevue Farm, Guilden Sutton, Chester.
Fe.	Grubb, N. H.	...	The Research Station, East Malling, Kent.
A.A.	Grude, I. N.	...	Grude's Planteskole, Sandnes, Norway.
A.A.	Guest, Philip R.	...	Moor Game Farm, Hawkhurst, Kent.
A.	Guilford, The Rt. Hon. the Earl of, D.L., J.P.	...	Waldershare Park, Dover, Kent.
A.A.	Gulland, F. A.	...	Heaton Cottage, Langley Heath, near Maidstone, Kent.
A.Fe.	Gunter, Major A. C., D.S.O.		Tregunter, Great Bromley, near Colchester, Essex.
A.A.	Gunter, E. E.	...	Grove Hill House, Hellingly, Sussex.
A.Fe.	Gunther, Mrs. H.	...	Tongswood, Hawkhurst, Kent.
A.A.	Gunyon, L. S.	...	Beckets Place, Barming, Maidstone, Kent.
Fe.	Gurr, H.	...	118 Maidstone Road, Chatham, Kent.
A.A.	Guthrie, E. F.	...	Mascall's Pound, Paddock Wood, Kent.
A.A.	Gwynne, H. A.	...	Mawbyns, Little Easton, Dunmow, Essex.
A.A.	Gwynne, Capt. H. V.	...	Barlands, Bishopston, Glamorgan.
A.A.	Hacker, Dr. H. P.	...	Long Acre, Downe, Kent.
Fe.	Haggard, A.	...	The Hilltop Fruit Farm, Ledbury, Herefordshire.
A.A.	Hales, A. T.	...	"Gwelo" Fruit Farm, Newington, Sittingbourne, Kent.
Fe.	Hales, H.	...	107 Rock Avenue, Gillingham, Kent.
A.	Hall Farming Co.	...	25 Sundridge Road, Bradford, Yorks.
A.A.	Hall, Dr. F.	...	Greenfields, Barham, near Canterbury, Kent.
A.Fe.	Hall, H. E.	...	Putlands, Paddock Wood, Kent.
A.	Hall, J. & E., Ltd.	...	Dartford, Kent.
A.A.	Hammond, Miss M. R.	...	c/o Messrs. Hubbocks, Dorton, Aylesbury, Bucks.
Fe.	Hampshire Branch, N.F.U.		Westgate Chambers, Winchester, Hants.
	*Hardy, Rt. Hon. Laurence		Sandling Park, Hythe, Kent.
Fo.	Harlow, T.	...	The Pines, Matfield, Kent.
A.A.	Harper, L.	...	Rixlade, Stoke Hill, near Exeter, Devon.
A.A.	Harraway, T. H. & Son	...	The Nurseries, Warminster, Wilts.
	*Harris, Rt. Hon. Lord	...	Belmont, Faversham, Kent.
Fe.	Harris, T. D.	...	Tudeley Hall, Tonbridge, Kent.
A.	Harrison, E. H.	...	Dux Court, High Halstow, near Rochester, Kent.
A.A.	Harrison, J. G.	...	Rose Farm, New Ridley Road, Stocksfield, Northumberland.
Fo.	Hart, D. B.	...	7 Bruce Grove, Church Hill, Orpington, Kent.
A.A.	Hart, Lt.-Col. Gilbert, O.B.E., M.C.	...	Keycroft Farm, Highleigh, near Chichester, Sussex.
A.A.	Hart, T. B.	...	Dean Farm, Beaconsfield, Bucks.
A.A.	Harter, Major J. F., D.S.O., M.C.	...	Langham Fruit Farms, Ltd., near Colchester, Essex.
A.	Hartley Bros.	...	Weavill's Fruit Farm, Fair Oak, Hants.
A.A.	Hartley Agricultural Co-operative Society, Ltd.		Hartley, Longfield, Kent.
A.A.	Harvey, Hugh	...	Bockingfold, Goudhurst, Kent.
A.A.	Harwood, Miss M.	...	Ringle Crouch Farm, Sandhurst, Kent.
A.Fe.	Hatfeild, Major H. S.	...	Rushett, Faversham, Kent.
A.A.	Hatton, Christopher H.	...	Avisford, Arundel, Sussex.
A.A.	Have, A., van der	...	Kapelle-Biezelinge, Holland.
Fe.	Haviland, Dr. F.	...	Branksome House, St. Leonards, Sussex.
A.A.	Hayman, Dr. W. S.	...	"Thorncliffe," 39 South Drive, Queen's Park, Bournemouth, Hants.
Fe.	Haynes, L.P.	...	Ockham, Bodiam, Hawkhurst, Kent.
A.A.	Head, W.	...	Government Botanic Gardens, Saharanpur, United Provinces, India.
A.A.	Heathcoke, G. R. S.	...	Bucklands, Hindhead, Surrey.
A.A.	Hempsall, C. L.	...	East Markham, Newark, Notts.
A.A.	Henderson, A. K. & Co.	...	Elmstone Court Farm, Preston, Canterbury, Kent.
A.A.	Henderson, T. A.	...	20 Crescent Road, London, N.8.
A.A.	Henderson, W. S.	...	Quince Orchard, Four Throws, Hawkhurst, Kent.
A.A.	Heseltine, R.	...	Cranbrook Farm, Newington, near Sittingbourne, Kent.
A.Fe.	Hewison, H. K.	...	Le Hurel Farm, Le Vallon, St. Martins, Guernsey, Channel Islands.

A.A.	Hewitt, Mrs. E. B.	...	Canning, Nova Scotia, Canada.
A.A.	Hey, G. L.	...	c/o The Murphy Chemical Co., Wheathampstead, near St. Albans, Herts.
A.A.	Heyst, B. G. van	...	Koningslaan 22, Utrecht, Holland.
A.Fe.	Higgs, C.	...	Farnborough Hall Farm, Farnborough, Kent.
	*Higgs, J. M.	...	Farnborough Hall Farm, Farnborough, near Sevenoaks, Kent.
Fe.	Higgs, J. V.	...	Owens Court Farm, Selling, Kent.
A.A.	Highwood, H. J.	...	Swigs Hole, Horsmonden, Kent.
A.A.	Highwood, S. W.	...	Sheerland Farm, Pluckley, Kent.
A.A.	Highwood, W.	...	Hertsfield, Marden, Kent.
A.A.	Hilder, R. W.	...	Little Halden Farm, Rolvenden, Kent.
A.A.	Hill, John	...	The Cross, Ledbury, Herefordshire.
A.A.	Hill, John & Sons	...	Spot Acre Nurseries, near Stone, Staffs.
A.Fe.	Hillard, E. A. P.	...	Puriton Manor, Bridgwater, Somerset.
Fo.	Hillier & Sons	...	West Hill Nurseries, Winchester, Hants.
A.Fe.	Hilling, T. & Co.	...	The Nurseries, Chobham, Woking, Surrey.
Fe.	Hills Green, Ltd.	...	Hills Green, Kirdford, Sussex.
Fe.	Hinge, A.	...	Homestead, Borden, Sittingbourne, Kent.
Fo.	Hinge, John	...	Brompton Farm, Frindsbury, near Rochester, Kent.
A.A.	Hirst, J. H. H.	...	Little Crockshard, Wingham, Kent.
A.A.	Hitchins, P. E. N.	...	(Hitchins & Auld, Ltd.), Sicklebank Nursery, Horeham Road, Sussex.
Fe.	Hoare, Miss C.	...	Hartridge Manor Farm, Cranbrook, Kent.
A.A.	Hocken, W.	...	Glassenbury Farm, Cranbrook, Kent.
A.A.	Hodgkin, B. M.	...	Russell Green Farm, Boreham, Chelmsford, Essex.
A.A.	Hogben, E. H.	...	Thanet Mill, Northwood, Ramsgate, Kent.
A.A.	Holdsworth, Mrs. R. K.	...	Belchambers Farm, Kirdford, near Billingshurst, Sussex.
A.	Holdsworth, R. K.	...	Belchambers Farm, Kirdford, near Billingshurst, Sussex.
A.A.	Hole, E. R.	...	Quantocks, Catlins Lane, Eastcote, Pinner, Middlesex.
Fe.	Hollands, E.	...	Green Farm, Shorne, Gravesend, Kent.
A.	Hollands, J. & F.	...	Kings Farm, Shorne, Gravesend, Kent.
A.A.	Holme, H. R.	...	The Thatched Cottage, Milbourne Port, Sherborne, Dorset.
Fe.	Holme, J. C.	...	Allhallows, Rochester, Kent.
A.A.	Holme, R. V.	...	c/o Ditton Court Farm, Ditton, near Maidstone, Kent.
A.A.	Holy, Dr. Karel	...	Svamberk, Poste Sevetin, Ces. Budejovice, Rep. Czechoslovakia.
A.A.	Homewood, G.	...	Castweazel Farm, Biddenden, Kent.
A.	Honess, E. West A.	...	Great Cheveney, Marden, Kent.
	*Honeyball, Col. J. F.	...	Newgardens, Teynham, Kent.
A.	Hooson, G. Lane	...	Church Farm, Ryarsh, West Malling, Kent.
A.A.	Hopkins, Capt. A.	...	Ormonde House, Sion Hill, Bath, Somerset.
A.A.	Hopwood, W. & Son	...	58 High Street, Cheltenham, Gloucester.
A.	Horne Bros.	...	Perry Hill, Cliffe, Kent.
A.	Horrocks, W. E.	...	Wheatley, Retford, Notts.
A.A.	Hotson, J. S.	...	Eskdale, Sidegate Lane West, Ipswich, Suffolk.
A.A.	Howard, W. F.	...	Copse Edge, Hillcrest Road, Hockley, Essex.
Fe.	Hubble Bros.	...	Hunton Court Farm, Hunton, near Maidstone, Kent.
A.	Hubble, A. W.	...	The Elms, Hunton, near Maidstone, Kent.
A.Fe.	Hubble, H. O.	...	Amsbury & Savage Farms, Hunton, near Maidstone, Kent.
A.A.	Hubble, Lloyd W.	...	China Farm, Harbledown, near Canterbury, Kent.
A.	Hubble, W. L.	...	New House Farm, Headcorn, Kent.
Fe.	Hubble, W. W.	...	Harbledown, Canterbury, Kent.
A.A.	Hubsch, E. Schmitz-	...	Fritzdorf b/Mechenheim, Rhld., Germany.
A.A.	Hubsch, H. Schmitz-	...	Merten, Kreis Bonn, Rhld., Germany.
A.A.	Hubsch, Otto Schmitz-	...	Merten, Kreis Bonn, Rhld., Germany.
Fo.	Hudson, W. S.	...	Park Gate Farm, Tenterden, Kent.
Fe.	Hume, P. G. Ross	...	32 Bishopsgate, London, E.C.2.
A.A.	Humphreys, Miss K.	...	Quintain House, Offham, Kent.
A.A.	Hunt, H. N.	...	The Oaks, Brenchley, Kent.
A.A.	Hunter, R. E.	...	The Gables, Goldbridge Road, Newick, Sussex.
Fo.	Hussey, E. W., M.A., D.L., J.P.	...	Scotney Castle, Lamberhurst, Kent.
A.A.	Huttner, A.	...	Altenweddingen, Bez. Magdeburg, Germany.
A.A.	Huxley, Henry	...	Wootton Close, Boars Hill, near Oxford.
A.A.	Hyett, H. E.	...	Becketts Grove, Matfield, Kent.
A.A.	Hynard, F. C.	...	Lower Austin Farm, Eynsford, Kent.

Fo.	Imperial Chemical Industries, Ltd. ...	Millbank, London, S.W.1.
A.	Ingleby, E. J. ...	The Forest and Orchard Nurseries, Milbury Heath, Falfield, Gloucester.
A.	Ingledew and Davenport ...	18/20 Southwark Street, Borough, London, S.E.1.
Fe.	Ingleton, E. J. ...	The Haven, Chalk, near Gravesend, Kent.
A.	Ingleton, H. J. ...	Fenn Farm, St. Marys, Rochester, Kent.
A.A.	Institut fur Gartnerischen Pflanzenbau ...	a.d Landwirtschaftliche Hochschule, Berlin-Dahlem, Konigen-Luise-Strasse 22, Germany.
Fo.	Institute of Brewing ...	Brewer's Hall, Addle Street, London, E.C.2.
Fe.	Isle of Ely Education Committee ...	Education Offices, County Hall, March, Cambs.
A.	Isle of Man Forestry Board	63 Athoe Street, Douglas, Isle of Man.
A.A.	Ivens, O. J. ...	23 Luttrell Avenue, Putney, London, S.W.15.
Fe.	Jackman, G. & Sons ...	The Nurseries, Woking, Surrey.
Fe.	Jackson & Son ...	Hockenden, Swanley, Kent.
A.A.	Jackson, W. F. ...	Glewstone Plantations, Glewstone, Herts.
A.	James, A. ...	Hill View, Waterloo Road, Cranbrook, Kent.
A.Fe.	Jenkins, H. R. ...	The Porch, Westhide, Hereford.
A.A.	Jennings, W. J. ...	Kennington Hall, Ashford, Kent.
A.A.	Joessel, P. H. ...	Institut des Recherches Agronomiques, Avignon, France.
A.A.	Johnson, G. C. ...	(Horticultural Superintendent), County Hall, Lewes, Sussex.
A.A.	Johnson, P. E. ...	Dingleside, Haile, Cheshire.
A.A.	Jones, W. H. Maelor- ...	The Grove Fruit and Poultry Farm, Epsom Road, West Horsley, Surrey.
A.A.	Jongh, Wed P. de., Ltd. ...	Nurserymen, Goes, Holland.
A.	Jordan, Lt.-Col. P. O. L. ...	Stubble Hill, Harrietsham, Kent.
A.A.	Juckes, Ralph ...	Milner Court, Sturry, Kent.
A.A.	Jungquist, Eric ...	Messrs. A. B. Jungquist & Svennevig, Bjerred, Malmo, Sweden.
A.	Kakebeeke, F. ...	Fruitgrower, Goes, Holland.
A.Fe.	Keeble, J. R. & Son ...	Brantham Hall, Manningtree, Essex,
A.A.	Kelly, W. A. ...	Ballaqueeney, Port St. Mary, Isle of Man.
Fe.	Kelsey, E. B. ...	Nether Quaives, Wickhambreaux, Canterbury, Kent.
A.Fe.	Kemsley, J. T. ...	Hazells Farm, Southfleet, Kent.
A.A.	Kennard, T. ...	Handicrafts and Gardening Centre, College Road, Margate, Kent.
Fo.	Kent Education Committee	Springfield, Maidstone, Kent.
A.A.	Kenward, R. ...	Udimore, Rye, Sussex.
A.	Kenyon, G. H. ...	" Ricklesmere," Kirdford, near Billingshurst, Sussex.
A.A.	Kiddle, J. A. C. ...	Newlands, Wickham Bishops, Witham, Essex.
A.A.	Kingdon, E. C. ...	Castlemans, Sedlescombe, Battle, Sussex.
A.A.	Kingsley Fruit Farm and Nursery ...	Kingsley, Bordon, Hants.
A.Fe.	Kipping, C. T. ...	Spitalfields Market, London, E.1.
A.	Kipping, H. G. ...	Bartrams Farm, Sevenoaks, Kent.
A.A.	Kirkhope, W. G. ...	Felmere, Felbridge, East Grinstead, Sussex.
A.A.	Kirwood, A. S. D. ...	Capel Green Orchards, Five Oak Green, Tonbridge, Kent.
A.A.	Kitcat, S. A. P. ...	Warling Dean, Esher, Surrey.
Fo.	Kitchin, J., J.P. ...	Boughton Place, Sandway, near Maidstone, Kent.
A.Fe.	Kleef, G. van & Co. ...	The Nurseries, Boskoop, Holland.
Fo.	Kleinwort, H. G. ...	45 Belgrave Square, London, S.W.1.
A.A.	Lacey, G. H. ...	Warmley, near Bristol.
A.A.	Lambert, Lt. D. M. ...	Manor Fruit Farm, Danbury, Chelmsford, Essex.
A.A.	Lambert, E. H. ...	Estate Office, Paddock Wood, Kent.
A.A.	Lambton, Brig.-Gen. Hon. C., D.S.O. ...	Mortimer Hill, Mortimer, Berks.
A.A.	Lambton, G. ...	Tingrith Manor, Bletchley, Bucks.
A.A.	Lammas, R. T. ...	Mill House, East Hendred, Wantage, Berks.
A.Fe.	Lamont, J. C. ...	King's Barn, Matfield, Kent.
A.A.	Landale, Capt. H. R. ...	Ewell Manor, West Farleigh, Kent.
A.A.	Landsforeningen Dansk Frugtavl ...	" Akselborg," Jagersprus, Denmark.

Fo.	Langlands, J., Jnr.	Darenth Court Farm, Darenth, Dartford, Kent.
A.A.	Langman, A. E. B.	County Offices, Aylesbury, Bucks.
A.A.	Langridge, R. T.	Hill Place Farm, Yalding, Kent.
Fe.	Large, J. D.	Cherry Gardens, Goudhurst, Kent.
A.A.	Large, W. A.	Mabledon Farm, Tonbridge, Kent.
A.A.	Larkin, W. K.	Capel Cross, Horsmonden, Kent.
A.A.	Larkin, W. R.	Capel Cross, Horsmonden, Kent.
A.	Latter & Sons	Borough, London, S.E.1.
A.A.	Lawrence, F. & J.	Dabb's Place Farm, Cobham, Kent.
A.	Lawrence, Geo.	Hayle, Horsmonden, Kent.
Fe.	Lawrey, John	Covent Garden Market, London, W.C.2.
A.A.	Lawrie, P. A.	Leigh Bridge Farm, Headcorn, Ashford, Kent.
A.A.	Lawson, Francis de M.	Tobo, Elburton, Devon.
A.Fe.	Lawson, H. P.	Lynbrook, Knaphill, Woking, Surrey.
Fe.	Laxton Bros.	63 High Street, Bedford.
A.A.	Leathart, J. G.	Withycombe House, Exmouth, S. Devon.
A.A.	Leavey, G. E.	Parsonage Farm, Stansted, Kent.
Fo.	Lee, C. & Son	Crockenhill, Swanley, Kent.
A.A.	Lee, Ralph T.	Stake Farm, Godden Green, Sevenoaks, Kent.
A.A.	Leech, H. L.	Lunevale Products, Ltd., Queen's Mill, Lancaster.
A.Fe.	Leeds Castle Estate	Leeds Castle, near Maidstone, Kent.
A.A.	Lefroy, L.	23 Sumner Place, London, S.W.7.
A.A.	Leney, A. M.	32 Shorncliffe Road, Folkestone, Kent.
Fe.	Leney, H.	Selling Court, Faversham, Kent.
A.Fe.	Leney, P.	Eaton Cottage, Benenden, Kent.
A.	Lennard, Lt.-Col. Sir H. A. H. F.	Roughetts, Hildenborough, Kent.
A.Fe.	Levett, E. G.	The Ridgeway, Brenchley, Kent.
A.	Lewis, E. H. & Son, Ltd.	25 James Street, Covent Garden, London, W.C.2.
A.A.	Lewis, H. D.	Combwell Priory, Flimwell, Hawkhurst, Kent.
A.	Lewis, J.	West Bank, Borough Green, Kent.
A.A.	Lewis, N. S.	Mumford, Wittersham, Kent.
A.	Lidiard, B. S.	Waltham St. Lawrence Fruit Farm, Twyford, Berks.
Fo.	Lillywhite, W. E.	Wincheap Farm, Thanington, Canterbury, Kent.
Fe.	Linfield, A. G.	The Pallant, Chesswood Road, Worthing, Sussex.
A.A.	List, J. N.	North Lodge, St. Catherine's, Guildford, Surrey.
Fe.	Little, S. H.	Crouch, Borough Green, Sevenoaks, Kent.
A.A.	Lloyd, A. H.	Imperial Forestry Institute, University of Oxford, Oxford.
A.A.	Lloyd, Sir John B., Kt.	Foxbury, Stone Street, near Sevenoaks, Kent.
A.	Lobjoit, Sir Wm. G., Kt., O.B.E. J.P.	Oakdene, Wooburn, Wooburn Green, Bucks.
A.A.	Locket, F.	Shirrenden, Horsmonden, Kent.
Fe.	London School Gardening Association	95 Belgrave Road, London, S.W.1.
Fe.	Long, Glover	Dairy Farm, Higham, Rochester, Kent.
A.A.	Low, E. F.	White Barn Farm, Matfield, Kent.
Fo.	Low, Stuart	Dingleden Fruit Farm, Benenden, Kent.
A.A.	Lowndes, Miss R.	Broad Oak, Buxted, Sussex.
Fo.	Luck, A. G.	Thornton, St. James Road, Tunbridge Wells, Kent.
A.A.	Luck, Col. B. J. M., C.M.G., D.S.O., J.P.	The Hermitage, West Malling, Kent.
A.A.	Luck, W. H.	Peckham Place, East Peckham, Kent.
A.A.	Luke, F. A. Fenwick	25 Molyneux Park Road, Tunbridge Wells, Kent.
Fe.	Lumsden, J.	The Dell, Stone Street, Sevenoaks, Kent.
A.	Lupton, G. H.	Elgin, Cape Province, South Africa.
A.A.	Macdonald, Lt.-Col. R. W.	Lealane Wood Fruit Farm, Ltd., Great Braxted, Witham, Essex.
A.A.	Macfadyen, E.	Meopham Bank, near Tonbridge, Kent.
A.A.	MacFarlan, Lt.-Col. J. B.	Invermay, Knowle, Budleigh Salterton, Devon.
A.	Mackinnon, Sir P. G., Kt.	High Quarry, Crockham Hill, Edenbridge, Kent.
A.A.	Maclean, G. A.	Heybridge, Prestbury, Macclesfield, Cheshire.
A.	Mackledon, E.	Grove House, Bobbing, near Sittingbourne, Kent.
A.A.	MacLysaght, E.	Hazelwood, Mallow, Co. Cork, Irish Free State.
A.	Macnee, E. A.	The Orchards, Writtle, Essex.
Fo.	Maidstone Branch, N.F.U.	6/8 Market Buildings, Maidstone, Kent.
Fe.	Manger & Henley	Hop Factors, 59 High Street, Borough, London, S.E.1.
A.A.	Mann, P.	Bolebroke, Hartfield, Sussex.

Fe.	Mann, W. E. ...	Carmuirs, Soham, Cambs.
Fe.	Mannington, E., Exors. of ...	Tanner House, Marden, Kent.
A.A.	Manwaring, G. V. ...	The Grove, Penshurst, Kent.
A.	Manwaring, H. T.W. ...	Rams Hill, Horsmonden, Kent.
Fo.	Manwaring, P., J.P. ...	" Crossway," 4 Knole Paddock, Sevenoaks, Kent.
A.	Manwaring, W. & F. ...	Martins Farm, Collier Street, Marden, Kent.
A.A.	Marden Branch, N.F.U. ...	9 King Street, Maidstone, Kent.
Fe.	Marden Fruitgrowers' Association ...	Marden, Kent.
A	Marriage, W. ...	Brabourne Farm, Sevenoaks, Kent.
A.A.	Marshall, F. W. ...	Furnace Mill Farm, Lamberhurst, Kent.
A.Fe.	Marten, Sir Amberson B., Kt., LL.D., M.A. ...	Gedges, Matfield, Paddock Wood, Kent.
A.A.	Mash, H. J., Ltd. ...	Torrington Farm, Chesham, Bucks.
A.Fe.	Mash, Martin ...	Woodside, Ashley Green, Chesham, Bucks.
A.A.	Master, Capt. C. F. O. ...	Amblehurst, Wisborough Green, Sussex.
A.A.	Master, C. H. ...	Shakespeare House, Sandgate, Kent.
Fo.	Mather, C. J. ...	Grange Farm, Barsham, Suffolk.
A.A.	Mathiesens Planteskole ...	Korsor, Denmark.
A.A.	Matthews, F. P. ...	The Nurseries, Harlington, Hayes, Middlesex.
A.	Matthews, J. H. ...	Calverts Buildings, 52 Borough High Street, London, S.E.1.
Fo.	Maxse, Gen. Sir Ivor, K.C.B., C.B., C.V.O., D.S.O., F.R.G.S. ...	The Maxey Fruit Co., Ltd., Fittleworth, Sussex.
A.	Maxse, Capt. John ...	Coldstream Guards, 1 Priory Grove, London, S.W.10.
Fe.	Maxted, J. D., J.P. ...	Newlands, Teynham, Kent.
Fe.	Maxwell, W. ...	Westwood Farm, Sidcup, Kent.
Fo.	May, G. ...	" Oakmount," Allington, near Maidstone, Kent.
Fo.	May, Stuart ...	Gallants Farm, East Farleigh, Maidstone, Kent.
A.A.	May, W. F. ...	Fairlawn, 36 Howard Road, Coulsdon, Surrey.
A.	May, W. H. & H. Le ...	67 Borough High Street, London, S.E.1.
	*McAndrew, Miss ...	Guildables, Edenbridge, Kent.
A.A.	McDiarmid, Miss D. M. R.	Trebant, Aetarnum, Launceston, Cornwall.
A.A.	McKnight, W. A. ...	Wellington Farm, Cook's Mill Green, Writtle, Essex.
Fe.	McLean, L. ...	St. Mary's Hall, Hoo, near Rochester, Kent.
Fe.	McLean, T. B. ...	East Court, Chalk, Gravesend, Kent.
A.A.	Meeke, B. D. ...	New Farm, Leckford, Stockbridge, Hants.
A.A.	Menneer, R. P. ...	Westerhill Farm, Linton, near Maidstone, Kent.
Fe.	Mercer, A. L. ...	Norton Court, near Sittingbourne, Kent.
A.A.	Mercer, J. C. H. ...	Heath Farm House, East Malling, near Maidstone, Kent.
A.	Mercer, R. ...	Church House, Rodmersham, near Sittingbourne, Kent.
A.	Mercer, R. M. ...	The Batteries, Lynsted, Kent.
A.A.	Merricks, Jack ...	Manor House, Jeklesham, Winchelsea, Sussex.
Fo.	Merryweather, H. & Sons. Ltd. ...	The Nurseries, Southwell, Notts.
A.A.	Methven, H. F. ...	Spa Works, Galleywall Road, London, S.E.16.
A.A.	Michell, A. H. ...	Ramridge, Andover, Hants.
A.A.	Michell, Miss M. ...	Dorton, near Aylesbury, Bucks.
A.	Miles, W. ...	Wall End Farm, Isle of Grain, near Rochester, Kent.
A.A.	Miles, W. & Co., Ltd. ...	16 Church Road, Hove, Sussex.
A.A.	Millar, Chas., Jnr. ...	Rhodes Cottage, Rattray, Blairgowrie, Perthshire, Scotland.
Fo.	Miller, A. T. ...	Wested Farm, Swanley, Kent.
A.A.	Miller, G. ...	Pigeon House Orchard, Newington, near Sittingbourne, Kent.
Fo.	Miller, G. J. ...	Court Lodge Farm, Chelsfield, Kent.
A.A.	Miller, H. Eric ...	Oldhouse, Ewhurst Green, Surrey.
A.A	Mills, Lewis H. ...	" Normandene," Linton Road, Loose, near Maidstone, Kent.
A.	Milner, The Rt. Hon. Viscountess ...	14 Manchester Square, London, W.1.
A.Fe.	Milvain, W. ...	Cockerhurst Farm, Shoreham, Sevenoaks, Kent.
Fo.	Miskin, G. V. ...	Ifield Court, Gravesend, Kent.
A.A	Miskin, P. K. ...	Weavers, Marden, Kent.
Fe.	Mitchell, R. & D. ...	Pelican Farm, Wateringbury, Kent.
A.A.	Mitchell, W. H. ...	Orchard House, Westwick, Norwich.
A.	Mogg, Lt.-Col. Graham Rees	Clifford Manor, Stratford-on-Avon, Warwickshire.
A.A.	Molesworth, S. F. ...	Sundridge Farm, Boughton Aluph, Ashford, Kent.
A.A.	Molyneux, Brig.-Gen. F. C. More- ...	Loseley Park, Guildford, Surrey.

Fo.	Mond, Sir R. L., Kt., LL.D., M.A., F.S.A., F.R.S., Ed., F.Ph.S., F.G.S., F.C.S., F.Z.S., J.P. ...	9 Cavendish Square, London, W.1.
A.A.	Monins, J. E., J.P. ...	Ringwould, near Dover, Kent.
A.A.	Monro, Geo. ...	4 Tavistock Street, Covent Garden, London, W.C.2.
Fo.	Monro, Geo., Ltd. ...	Covent Garden Market, London, W.C.2.
A.	Moore, D. J. ...	Nichol Farm, Teynham, Kent.
A.Fe.	Moore, A. D. ...	"Coulings," East Hendred, Wantage, Berks.
A.A.	Moore, E. G. & J. H. ...	Park Farm, Somerhill, Tonbridge, Kent.
A.A.	Moore, F. W. & Co., Ltd. ...	Clarence House, 8 Arthur Street, London Bridge, London, E.C.4.
A.A.	Moore, Col. R. H. H. ...	Painswick Lodge, Cheltenham, Glos.
A.A.	Moore, W. L. ...	The Church House, Shelsley Beauchamp, Worcester.
A.A.	Moorhouse, J. H. ...	Jupes Hill, Dedham, Essex.
A.A.	Morel, R. C. ...	Dartington Hall, Ltd., Totnes, S. Devon.
Fe.	Morford, L. ...	Little Chillmill, Brenchley, Paddock Wood, Kent.
A.Fe.	Morgan, R. C. ...	Little Whatmans, Biddenden, Kent.
A.A.	Morison, G. C. T. ...	Christ Church, Oxford.
Fe.	Morley, C. ...	Station Nurseries, Fordham, near Ely, Cambs.
A.A.	Moseley, R. ...	Sherfield English, Romsey, Hants.
A.A.	Moss, E. O. ...	Swan Street Farm, Charing, Kent.
A.A.	Moss, P. J. ...	Plummers Farm, Sissinghurst, Cranbrook, Kent.
A.A.	Mount Barker Fruitgrowers' Co-operative Society, Ltd.	Mount Barker, Western Australia.
A.A.	Mount, D. R. ...	Woolton House, Bekesbourne, Canterbury, Kent.
A.A.	Mount, J. H. ...	Woolton House, Bekesbourne, Canterbury, Kent.
A.	Mount, Herbert ...	Woolton Farm, Bekesbourne, Canterbury, Kent.
Fo.	Mount, H. G. ...	The Nurseries, Canterbury, Kent.
A.A.	Mount, J. W. S. ...	Little Barton, Canterbury, Kent.
A.A.	Mount, G. P. ...	Howfield, Chartham, Canterbury, Kent.
A.Fe.	Mount, P. C. ...	Howfield, Chartham, Canterbury, Kent.
A.A.	Mount, R. S. ...	Denstead, Chartham, near Canterbury, Kent.
Fo.	Mount, S. W. ...	Hode Farm, Patrixbourne, Canterbury, Kent.
A.A.	Moxly, Com. S. H. S., R.N.	Boldre Lane, near Lymington, Hants.
Fo.	Moyne, The Rt. Hon. Lord, P.C., D.S.O. ...	10 Grosvenor Place, London, S.W.1.
A.A.	Muddle, F. S. ...	Scords Farm, Toy's Hill, near Sevenoaks, Kent.
A.	Muggeridge, A. ...	Turkey Farm, Stoke, Kent.
A.	Muggeridge, E. ...	White House Farm, Isle of Grain, Kent.
A.A.	Mugeridge, F. ...	North Street Farm, Hoo, near Rochester, Kent.
A.A.	Mumford, C. A. ...	Three Springs, Pershore, Worcs.
A.A.	Murch, C. E. ...	Ellenden Farm, near Whitstable, Kent.
Fo.	Murdoch, Lt.-Col. Clive, D.S.O. ...	Westerhill, Linton, near Maidstone, Kent.
A.Fo.	Murphy Chemical Co., Ltd.	Wheathampstead, near St. Albans, Herts.
A.A.	Murray, Miss K. ...	Palmiet River, Elgin, Cape Province, South Africa.
A.	Mursell, Peter ...	Dounhurst Farm, Wisborough Green, Billingshurst, Sussex.
A.A.	Murton, E. ...	Langton, Hawksdown, Walmer, Kent.
A.	Nairn, W. ...	Erichtbank, Blairgowrie, Perthshire, Scotland.
A.Fe.	Napier, J. R. H. ...	Little Slifehurst Farm, Kirdford, Sussex.
A.	Nash, T. H. ...	Garland Hill, St. Paul's Cray, Kent.
Fo.	National Federation of Fruit and Potato Growers ...	Russell Chambers, Market Square, Covent Garden, London, W.C.2.
A.A.	National Provincial Bank, Ltd. ...	High Street, Maidstone, Kent.
A.A.	Neame, Basil D. ...	Colkins, Faversham, Kent.
A.	Neame, F. Ivo ...	The Offices, Macknade, Faversham, Kent.
A.A.	Neame, Mrs. T. ...	Colkins, Faversham, Kent.
Fo.	Neame, T. ...	The Offices, Macknade, Faversham, Kent.
A.A.	Neill, S. B. ...	Sunnyhaye Fruit Farm, Woodbury, near Exeter, Devon.
A.A.	Nes Kz., C. B. van ...	Boomkweeker, Boskoop, Dorpstr. W.Z.20, Holland.
Fo.	Nettlefold, A. ...	The Park, Wrotham, Kent.
A.Fe.	New Zealand Fruit Board ...	Box 882, Wellington, New Zealand.
A.A.	Newman, Miss M. G. ...	High Hurstwood, near Uckfield, Sussex.
A.A.	Newman, T. ...	Pitfield, Rudgwick, Horsham, Sussex.
A.A.	Nicholls, W. A. & Sons, Ltd.	Smithfield Market, Manchester.

A.	Nix, C. G. A. ...	Tilgate, Crawley, Sussex.
Fe.	Noakes, W. J. ...	Trottenden, Goudhurst, Kent.
A.A.	Noble, Major W. J. W. ...	Mayfield, Kingswood Road, Shortlands, Kent.
A.A.	Norbury, F. P. ...	Sherridge, near Malvern, Worcester.
Fo.	Norfolk County Council ...	The Shirehouse, Norwich.
A.A.	Norfolk East Fruit Growers' Association ...	Estate Office, Langley Park, Norwich.
A.	Norman, A. C. ...	The Rookery, Bromley Common, Bromley, Kent.
A.A.	Normand, Col. S. R. ...	Manor Lodge, Stoughton, near Guildford, Surrey.
Fe.	Northampton Branch, N.F.U. ...	11/12 Lloyds Bank Chambers, George Row, Northampton.
A.Fe.	Northbourne, Rt. Hon. Lord	Northbourne Court, Deal, Kent.
Fe.	North of England Horticultural Society ...	Preston Rectory, Lavenham, Suffolk.
Fe.	Norton, Capt. R. A., R.N. ...	Downs House, Yalding, Kent.
Fo.	Notcutt, R. C., J.P., F.L.S.	Woodbridge, Suffolk.
A.A.	Nott, G. A. ...	Newnham Farms, Newnham Bridge, near Tenbury Wells, Worcester.
A.A.	Oates, B. W. G. ...	Alton Hall, Holbrook, Suffolk.
A.A.	O'Brien, Hugh V. ...	Monare, Foynes Island, Limerick, Irish Free State.
A.A.	Offen, H. ...	High Street, Staplehurst, Kent.
A.Fe.	Ogilvie, G. N. ...	Cox's, Harpenden, Herts.
A.A.	Okey, T. ...	Westwood Farm, Westerham, Kent.
A.	Osenton, Stanley ...	Dalham Farm, High Halstow, Rochester, Kent.
A.	Osenton, W. F. ...	Buckhole Farm, High Halstow, Rochester, Kent.
A.Fe.	Ostenfeld, H. ...	Klagshamn, Sweden.
Fo.	Overy, E. I. ...	Mascalls Court, Paddock Wood, Kent.
Fe.	Oyler, Potter, Ltd. ...	Fruit Growers, Malt House, Lynsted, Kent.
A.A.	Packham, A. L. ...	79 Portland Place, London, W.1.
Fe.	Paddock Wood Branch, N.F.U. ...	Tudor House, King Street, Maidstone, Kent.
A.A.	Padwick, F. H., C.B.E., M.A., J.P. ...	The Red House, West Ashling, Chichester, Sussex.
A.A.	Page, A. ...	Ashgrove, Knockholt, Kent.
Fe.	Pain, A. E. ...	Black Hall Farm, Sevenoaks, Kent.
A.A.	Palmer, A. J. ...	Cawdon House, Melbourn, near Royston, Herts.
A.A.	Palmer, B. J. ...	Cawdon House, Melbourn, near Royston, Herts.
A.A.	Palmer, G. E. H. ...	Prior's Court, Chieveley, Berks.
A.A.	Palmer, The Hon. L. ...	Hoathly Hill, West Hoathly, Sussex.
A.	Palmer, R. E. ...	Park Farm, Brasted, Kent.
A.A.	Pan Britannica Industries, Ltd. ...	West Bromwich, Staffs.
A.A.	Parish, Capt. A. J., C.B., C.B.E., M.A., R.N. ...	Afton Lodge, Freshwater, Isle of Wight.
A.A.	Parker, Rev. Prebendary T. H. ...	Breinton Vicarage, Hereford.
A.A.	Parrett, H. F. ...	Copthall, Furnace Lane, Lamberhurst, Kent.
A.A.	Parsons, W. J. ...	Great Braxted Hall, Witham, Essex.
A.A.	Patrick, W. T., J.P. ...	Treverward, Nightingale Road, Guildford, Surrey.
A.A.	Pattenson, G. P. ...	Brick Kiln Farm, Gt. Horkesley, Colchester, Essex.
A.Fe.	Pawsey, C. R. ...	c/o Lloyds Bank, Ltd., King's Branch, Pall Mall, London, S.W.1.
A.A.	Payne, F. W., J.P. ...	55 Anerley Park, London, S.E.20.
A.A.	Payne, G. A. ...	Prestons, Ightham, Kent.
Fo.	Payne, H. ...	Court Lodge Farm, West Farleigh, near Maidstone, Kent.
A.A.	Payne, H. W. ...	The Old Parsonage, Brenchley, Kent.
A.A.	Peacock, A. ...	Chimhams Farm, Kingsdown, near Sevenoaks, Kent.
A.A.	Pearse, F. H. ...	White House, West Walton, Wisbech, Cambs.
A.Fe.	Pearson, H. Gaudern ...	Castle Farm, Hadlow, Kent.
Fo.	Pearson, J. R. & Sons ...	The Nurseries, Lowdham, Notts.
Fe.	Peerless, T. ...	Little Brook Manor, Dartford, Kent.
A.	Pemberton, D. Leigh ...	Torry Hill, Sittingbourne, Kent.
A.A.	Pemble, C. G. ...	Tatlingbury, Capel, near Tonbridge, Kent.
Fe.	Pennell & Sons ...	Seed Merchants and Nurserymen, Lincoln.
A.A.	Penney, F. Campbell ...	c/o Messrs. Kirdford Growers, Ltd., Kirdford, Billingshurst, Sussex.
A.A.	Perkin, W. Hilton ...	Roman Way, Upper Bassett, Southampton, Hants.

Fo.	Perree, J. A. ...	Oaklands, St. Saviours, Jersey, Channel Islands.
A.A.	Pettit, G. J. E. ...	Pickforde, Ticehurst, Sussex.
A.A.	Phayre, Lt.-Col. R., O.B.E., D.L. ...	Belgaum, Park Road West, Woking, Surrey.
A.A.	Philips, Lt.-Col. J. C. ...	Stone House, Sandhurst, Kent.
Fo.	Philpotts, G. S. ...	Oakfield, Foxrock, Co. Dublin, Ireland.
A.A.	Pickrell, L. ...	The Fairway, Vera Avenue, Grange Park, London, N.21.
Fo.	Pickstone, H. E. V. ...	Lekkerwijn, P.O. Groot Drakenstein, Cape Province, South Africa.
A.A.	Pierce, F. G. ...	Orchard Place, Comp, Borough Green, Kent.
A.A.	Piper, J. G. ...	Mount Pleasant, Marden, Kent.
A.A.	Pitt, Brig.-Gen. T. M. S., J.P. ...	Pett Place, Charing, Kent.
A.A.	Pivert, Mons. A. ...	Groupement pour l'Amelioration de la Production Fruitere, 5 Rue Alberic Dubois, Angers, France.
A.A.	Player, H. P. ...	Stone Corner, Stone-in-Oxney, Kent.
A.A.	Pluck, N. ...	"Dodnash," Bentley, Suffolk.
A.A.	Plumb, G. ...	Nurseries, Sutton Road, Leverington, Wisbech, Cambs.
Fo.	Podmore, J. H. ...	Moatlands, Paddock Wood, Kent.
A.A.	Porter, E. L. & Son ...	Manor House, Haddenham, Ely, Cambs.
A.A.	Potter, C. A. ...	Penn Lodge, Beaconsfield, Bucks.
A.A.	Poupart, J. ...	Fairport, Bursledon, Hants.
A.A.	Praill, F. E. M., N.D.H. ...	Messrs. H. & A. Pullen Burry, Ltd., Sompting, Worthing, Sussex.
Fo.	Prall & Sons ...	Matfield Nurseries, Paddock Wood, Kent.
A.Fe.	Prang Begar Rubber Estates, Ltd. ...	1/4 Gt. Tower Street, London, E.C.3.
A.A.	Pratt, C. H. ...	Garnsgate, Long Sutton, Lincs.
A.A.	Pree, Maj.-Gen., H. de, C.B., C.M.G., D.S.O. ...	Oak Hill House, Beckley, Sussex.
A.A.	Prichard, Brig.-Gen. C. S., C.B., D.S.O. ...	Parslow's Hillock, Princes Risborough, Bucks.
A.A.	Proctor, R. W. & Sons ...	Ashgate Road, New Square, Chesterfield, Derby.
A.A.	Punnett, A. W. ...	Applegarth, Matfield, Kent.
Fe.	Purcell, E. ...	St. Ita's, Banim Terrace, Kilkenny, Ireland.
A.	Pye, J. W. ...	Ranscombe Farm, Cuxton, Rochester, Kent.
A.A.	Pye, L. K. ...	Burleigh, Cobham, Kent.
Fe.	Pye, Wm. ...	Jeskyns Court, Cobham, Rochester, Kent.
Fe.	Pyne, G. ...	Denver Nurseries, Topsham, Devon.
A.A.	Quas, R. ...	Chithurst Fruit Farm, Rogate, Petersfield, Hants.
A.A.	Quayle, J. B. ...	Valley Farm Bungalow, Brantham, Manningtree, Essex.
A.A.	Ralling, H. St. G. ...	Woodlands, Brenchley, Kent.
Fo.	Raynham, J. A. ...	Dairy Farm, Marden, Kent.
Fe.	Reader, H. ...	Pike Fish Farm, Yalding, Kent.
A.A.	Redman, W. C. ...	Culham Cottage, Canterbury Road, Margate, Kent.
A.A.	Reed, T. ...	London Road, Stroud, Glos.
A.A.	Reeves, F. ...	The Court Lodge, Yalding, Kent.
A.A.	Reeves, John ...	Bluehills, Yalding, Kent.
A.A.	Reid, H. F. B. ...	Sutherland House, Surbiton, Surrey.
A.A.	Reid, D. M. ...	Green Trees, Tonbridge, Kent.
A.	Renwick, J. ...	Panthurst Farm, Weald, Kent.
A.A.	Reynolds, E. ...	Clipston House, Church Road, Watford, Herts.
A.A.	Reynolds, Capt. J. W. ...	Tudor House, Aldington, Ashford, Kent.
Fe.	Rice, H. E. H. ...	North Court, Eastry, Kent.
Fe.	Richards, W. ...	Poulters, Bentley, Hants.
A.A.	Richardson, R. C. ...	The Frith Fruit Farm, Ledbury, Herefordshire.
A.A.	Rickards, W. J. ...	The Hoath, St. Martin's Hill, Canterbury, Kent.
A.A.	Rickwood, H. J. ...	Ellenden, Hawkhurst, Kent.
A.Fe.	Ridley, F. R. ...	10 Russell Street, Covent Garden, London, W.C.2.
A.A.	Rietsema, Dr. I. ...	12 Teteringsche Dijk, at Breda, Holland.
A.A.	Rigden, C., Exors. of ...	Plumford Farm, Ospringe, Faversham, Kent.
A.A.	Rimmer, John ...	Roby Farm, Roby, near Liverpool, Lancs.
A.A.	Ripper, A. M. ...	Coombe Farm, Maidstone, Kent.
Fo.	Rivers, T. & Son, Ltd. ...	The Nurseries, Sawbridgeworth, Herts.
A.Fe.	Robbins, A. J. ...	Vicarage Farm, Hounslow, Middlesex.
A.A.	Robbins, J. & F. ...	Branns Farm, Marden, Kent.

A.A.	Roberts, A. E. ...	Fruit Grower and Nurseryman, Wickham, Hants.
A.A.	Roberts, D. ...	Saddlers Hall, Eynsford, Kent.
A.	Roberts, H. G. ...	Huntley Cottage, Budleigh Salterton, S. Devon.
A.A.	Roberts, J. C. ...	Riddy Shott, Hitchin, Herts.
A.A.	Robertson, A. ...	Alva Gardens, Alva, Clackmannanshire.
A.A.	Robertson, C. D. ...	Bourne Farm, Sandhurst, Kent.
Fo.	Robertson, J. M. ...	Beluncle, Hoo, near Rochester, Kent.
A.A.	Robertson, W. A. ...	Drywick, Wendover, Bucks.
Fo.	Rochester Branch, N.F.U. ...	Cathedral Chambers, High Street, Rochester, Kent.
A.A.	Roemer, Prof. Dr. T. E. ...	Halle a.s. (Saale), Ludwig, Wucherershe 2, Germany.
Fe.	Rogers, Lt.-Col. J. M., D.S.O., J.P. ...	Riverhill, Sevenoaks, Kent.
Fo.	Rogers, Samuel ...	Roselands, Mottingham Lane, Eltham, London, S.E.9.
Fo.	Rogers, W. ...	Court Lodge, Horton Kirby, Kent.
A.	Rolvenden Branch, N.F.U.	Bull Farm, Rolvenden, Kent.
A.A.	Roman Catholic School for Agriculture and Horticulture ...	12 Teteringsche Dijk, at Breda, Holland.
A.A.	Roots, Richard C. ...	Maplescombe Farm, Farningham, Kent.
A.A.	Ross, Capt. W. A., C.M.G.	Scullsgate, Benenden, Kent.
A.Fe.	Roth, J. Ingold- ...	Derendingen, near Solothurn, Switzerland.
A.A.	Rowe, J. E. ...	Achimota College, Accra, Gold Coast, British West Africa.
A.A.	Rowntree, B. S. ...	The Cocoa Works, York.
A.A.	Roy, M. H. T. ...	Merton House Hotel, Christchurch Road, Reading, Berks.
A.A.	Russel, H. J. ...	The Lower Farm, Hatfield Peverel, Chelmsford, Essex.
A.	Ryall, R. B. ...	Thatches, Brenchley, Kent.
A.A.	Sale & Son ...	Nurserymen, East Berks Seed Warehouse, Wokingham, Berks.
A.A.	Salusbury, Major R. T. G.	Firgrove, Tidenham Chase, St. Briavels, Glos.
Fo.	Sandbach, G. L. Mackeson-	Littlebourne House, near Canterbury, Kent.
A.A.	Sanderson, Mrs. M. H. ...	Bottrells Farm House, Chalfont St. Giles, Bucks.
Fe.	Sandford, T. C. G. ...	Preshute House, Marlborough, Wilts.
A.A.	Sassoon, Michael ...	Hatherleigh, Matfield, Kent.
A.A.	Savage, F. D. ...	Jarmons, Collier Street, Marden, Kent.
A.A.	Savile, Lt.-Col. Wrey, D.S.O. ...	Whitehill House, Bordon, Hants.
A.A.	Savill, M. P. ...	Comenden Manor, Cranbrook, Kent.
A.A.	Sawers, B. L. ...	Dodges, Curtisden Green, Goudhurst, Kent.
A.A.	Saywell, H. J. ...	Agricultural Merchant, Tonbridge, Kent.
Fe.	Scott, Mrs. F. ...	Westmoor, Rainham, Kent.
A.A.	Scott, F. R. ...	Thornham Friars, Maidstone, Kent.
A.A.	Scott, T. ...	Holne, Newton Abbott, Devon.
A.Fe.	Scott, T. S. ...	Grove Farm, Hunton, near Maidstone, Kent.
A.A.	Scott, Lt.-Col. W. ...	Bridge House, Marden, Kent.
A.A.	Scrutton, Miss M. E. ...	Chickmarling, Udimore, near Rye, Sussex.
A.A.	Scutt, T. M. ...	Badlesmere Court, near Faversham, Kent.
Fo.	Seabrook & Sons, Ltd. ...	The Nurseries, Boreham, Chelmsford, Essex.
A.	Sedgwick, C. ...	Salter Heath Farm, Riverhead, Kent.
A.A.	Serpell, H. O., D.L., J.P. ...	Westcroft Park, Chobham, Surrey.
A.A.	Sharp, A. ...	Scraces Cottages, Barming, near Maidstone, Kent.
Fe.	Sheldon, W. ...	Long Lane Farm (North), Bexley Heath, Kent.
A.A.	Shepherd, D. F. ...	Ness Ziona, Palestine.
A.A.	Shepton, H. M. ...	Jeram Kuantan Rubber Estate, Kuantan, Pahang, Federated Malay States.
A.A.	Showell, H. B. ...	Clippesby Hall, Fleggburgh, Norfolk.
A.A.	Shuldham, Major W. F. Q.	Norton-sub-Hambdon Fruit Farm, Norton-sub-Hambdon, Somerset.
A.A.	Sillars, R. ...	Griffins, Sutton Valence, near Maidstone, Kent.
A.A.	Simcox, J. L. ...	Lletty'r Adar, Conway, Caernarvonshire.
Fe.	Simmons, C. ...	Stilstead, East Peckham, Kent.
A.A.	Simpson, P. A. ...	High Firs, Brenchley, Kent.
Fo.	Sittingbourne Branch, N.F.U. ...	Finch's Farm, Milstead, Sitingbourne, Kent.
A.A.	Skard, Prof. Olav ...	Norges Landbrukshoiskole, As, Norway.
A.A.	Sketch, G. ...	Orchards, Great Totham, Malden, Essex.
A.	Skilton, W. F. ...	6 Market Square, Bromley, Kent.
A.A.	Skinner, E. B. ...	Toutley Hall, Wokingham, Berks.

Fo.	Skinner, Thornton ...	White Lodge, Boughton Monchelsea, near Maidstone, Kent.
A.A.	Slayter, Lt.-Com. R. J., R.N. ...	The Long House, Dunsfold, Godalming, Surrey.
A.A.	Slocock, W. C. ...	Goldsworth Old Nursery, Woking, Surrey.
Fo.	Smith Bros. ...	Land Agents, Boughton Monchelsea, near Maidstone, Kent.
A.A.	Smith, B. N. ...	Drainage Farm, North Fen, Bourne, Spalding, Lincs.
A.A.	Smith, C. & Son ...	Caledonia Nursery, Guernsey, Channel Islands.
A.A.	Smith, Chas. E. ...	Monks House, Spalding, Lincs.
Fo.	Smith, C. S. ...	Elm House, Boughton Monchelsea, near Maidstone, Kent.
A.A.	Smith, D. Austin ...	Tweed Hill Cottage, Swanley, Kent.
A.A.	Smith, Dolphin ...	Mackrey End, Harpenden, Herts.
A.A.	Smith, Lt.-Com. E. R. A., R.N. ...	Heron's Farm, Kirdford, near Billingshurst, Sussex.
Fo.	Smith, F. ...	Loddington, Linton, near Maidstone, Kent.
A.A.	Smith, F. ...	Fant Farm, East Peckham, Kent.
A.A.	Smith, Col. G. E. S., D.S.O.	Goat Hall Fruit Farm, Galleywood, Chelmsford, Essex.
A.A.	Smith, R. ...	Crocklands, Trottiscliffe, near West Malling, Kent.
A.A.	Smith, R. W. Clifford ...	Eggarton, Godmersham, Canterbury, Kent.
A.A.	Smith, S. Austin ...	The Old Place, Swanley, Kent.
Fo.	Smith, Selby ...	Hall Place, Barming, near Maidstone, Kent.
A.	Snow, C. H. ...	Merriams, Leeds, Kent.
A.A.	Snoxell, F. ...	Fruit Grower and Market Gardener, Kingston, near Lewes, Sussex.
A.Fe.	Solignum, Ltd. ...	205 Borough High Street, London, S.E.1.
A.A.	Solley, G. C. ...	King's End Farm, Richborough, Sandwich, Kent.
A.A.	Southworth, W. ...	Ladywell, Spenser Road, Harpenden, Herts.
A.A.	Sowrey, J. ...	Yeoveney Moor, Staines, Middlesex.
	*Spence, Howard, M.I.Chem.E. ...	The Red House, Ainsdale, Southport, Lancs.
A.A.	Spender, A. R. ...	The Orchard, Boreham, Chelmsford, Essex.
Fo.	Spooner & Sons ...	The Nurseries, Hounslow, Middlesex.
A.A.	Spratt, W. H. ...	Hallery, Shurdington Road, Cheltenham, Gloucester.
A.Fe.	Stainton, E. ...	Barham Court, Canterbury, Kent.
Fe.	Staplehurst Branch, N.F.U.	9 King Street, Maidstone, Kent.
A.A.	Starkey, J. R. ...	Norwood Park, Southwell, Notts.
A.A.	Startup, T. R. ...	Little Hothfield, near Ashford, Kent.
Fo.	States Committee of Agriculture ...	Greffe Office, St. Helier, Jersey, Channel Islands.
A.A.	Stead, J. W. ...	Ulcombeden, Hawkhurst, Kent.
A.A.	Stedman, W. ...	Grange Farm, Gillingham, Kent.
Fe.	Steel, Major S. Strang ...	39 Portman Square, London, W.1.
A.A.	Stern, Dr. A. Landaner ...	1 Dollis Hill Lane, London, N.W.2.
A.	Stern, Miss R. F. ...	1 Dollis Hill Lane, London, N.W.2.
A.	Stevens, A. ...	Bell Lands, Newington, Kent.
A.	Stevens, E. ...	Uppertoes, Bobbing, near Sittingbourne, Kent.
A.A.	Stevens, G. E. ...	Bobbing, Sittingbourne, Kent.
A.A.	Stevens, H. ...	Squerryes Home Farm, Westerham, Kent.
A.A.	Stevens, J. ...	Forge Green, Westerham, Kent.
A.	Stevens, S. ...	Place Farm, Hartlip, Sittingbourne, Kent.
A.A.	Stewart, D. & Son, Ltd. ...	Ferndown Nurseries, near Wimborne, Dorset.
	*Stewart, James ...	Bloors Place, Rainham, Kent.
A.A.	Steynor, R. L. ...	Dyke House Fruit Farm, Dymock, Gloucester.
A.A.	Stokes, J. M. ...	Grower and Merchant, Evesham, Worcester.
A.A.	Stone, H. C. ...	Thanet Grange, Prince Avenue, Southend-on-Sea, Essex.
A.A.	Stonor, B. ...	The Laurels, Parkgate, Southampton, Hants.
A.A.	Strauss, E. A., J.P., M.P. ...	Kingston House, Abingdon, Berks.
Fe.	Streeten, F. O., J.P. ...	High Hilden, Tonbridge, Kent.
A.A.	Strickland, F. & Sons ...	67 George Street, Hastings, Sussex.
A.A.	Strong, Mrs. H. V. ...	Bewley, Ightham, Kent.
A.A.	Strouts, E. W. ...	Bishopsdale Farm, Biddenden, Kent.
A.	Strouts, R. S. ...	Court Hall, Sidbury, Sidmouth, Devon.
A	Strover, W. H. ...	The Cock Inn, Isle of Grain, near Rochester, Kent.
A.A.	Stuttaford, C. R. ...	Keenthorne Poultry Farm, Matfield, Kent.
A.Fo.	Surrey Agricultural Committee ...	County Hall, Kingston-upon-Thames, Surrey.
Fo.	Surrey Branch, N.F.U. ...	Market Buildings, Guildford, Surrey.
Fo.	Sussex (East) County Council Agricultural Committee	County Hall, Lewes, Sussex.

Fo.	Sussex (West) County Council Agricultural Committee	County Hall, Chichester, Sussex.
Fe.	Sutton, J. ...	Clement Street, Swanley, Kent.
A.A.	Swain, F. B. ...	"Conway," Villa Road, Higham, Kent.
A.A.	Sweet, C. J. ...	The Chantry, Boreham, Chelmsford, Essex.
A.	Swinstead, B. H. ...	Ivinghoe House, Ivinghoe, Leighton Buzzard, Beds.
A.A.	Talbot, B. ...	White House, Hadlow Road, Tonbridge, Kent.
A.A.	Tapsfield, W. ...	Whetstead, Five Oak Green, near Tonbridge, Kent.
A.A.	Tassell, L. W. ...	Westfield, Marden, Kent.
A.A.	Tate, Miss M. Y. E. ...	Hilden, Rye, Sussex.
A.A.	Taylor, A. E. ...	Little Frith Farm, Doddington, Kent.
A.A.	Taylor, B. ...	Tiptoe Fruit Farm, Hordle, Hants.
Fe.	Taylor, E. & Sons ...	Bell Farm, Barming, Maidstone, Kent.
A.A.	Taylor, E. E. ...	Chimhams Farm, Farningham, Kent.
A.A.	Taylor, L. E. ...	c/o "Valeside," Romford Road, Pembury Lower Green, near Tunbridge Wells, Kent.
A.A.	Taylor, W. Lawrence ...	Galleywood, Chelmsford, Essex.
Fo.	Technical Products, Ltd. ...	31 Great St. Helens, London, E.C.3.
A.A.	Terry, H. ...	Sydenham House, Wittersham, Kent.
Fe.	Theosophical Educational Trust ...	Broadway, Letchworth, Herts.
A.A.	Thomas, D. H. ...	Hardacre Farm, Preston, Canterbury, Kent.
A.Fe.	Thomas, John ...	Nouds Farm, Teynham, Kent.
Fo.	Thomas, W. J. ...	Brownings, Rodmersham, near Sittingbourne, Kent.
A.A.	Thomason, T. ...	110 Borstal Street, Borstal, Rochester, Kent.
A.A.	Thompson, Col. E. C. Meysey-, J.P., M.P. ...	Spellow Hill, Knaresborough, Yorks.
A.A.	Thompson, Mrs. L. G. ...	Blacklands, East Malling, Kent.
A.A.	Thoms, P. ...	Satins Hill Farm, Sissinghurst, Kent.
A.A.	Thynne, Lady Beatrice ...	Norton Hall, Daventry, Northants.
Fe.	Tickler, T. G. Ltd. ...	The Fruit Farms, Bradley, near Grimsby, Lincs.
A.A.	Timothy & Sandwith ...	Bracknell, Berks.
A.A.	Timson, J. W. L. ...	Furnace Farm, Lamberhurst, Kent.
A.A.	Tipples, F. S. ...	Sweetlands Farm, Staplehurst, Kent.
A.A.	Tipples, S. T. ...	Harts Heath, Staplehurst, Kent.
A.Fe.	Tipples, Wm. ...	Iden Grange, Staplehurst, Kent.
A.A.	Todd, M. A. ...	Coombe Gate, Wraxhall, Bristol, Glos.
	*Tolhurst, Thos. ...	Bennetts Farm, Horsmonden, Kent.
A.A.	Tolhurst, W. ...	Moat Farm, Five Oak Green, Tonbridge, Kent.
Fo.	Tolhurst, Major W. H. ...	The Palace Hotel, Southend-on-Sea, Essex.
A.A.	Tompsett, A. J. ...	Colts Hill Fruit Farm, Capel, near Tonbridge, Kent.
A.Fe.	Tompsett, P. & H. ...	Springfield Farm, Marden, Kent.
A.Fe.	Towner, J. F. ...	Salts Farm, Loose, near Maidstone, Kent.
A.Fe.	Townsend, C. Ltd. ...	Nursery and Seed Growing Establishments, Fordham, Ely, Cambs.
A.	Townsend, H. S. Marsham, J.P. ...	Scadbury Park, Chislehurst, Kent.
A.A.	Trechmann, N. G. ...	Fruit and Vegetable Grower, Pikelands, Harvington, Evesham, Worcester.
A.A.	Trehane, D. C. ...	Manor Farm, Hampreston, near Wimborne, Dorset.
Fe.	Treseder, W. & Co. ...	The Nurseries, Cardiff, Wales.
A.A.	Trier, E. ...	Fairlawn, West Horsley, Surrey.
A.A.	Tuker, G. E. ...	Butts Green Orchards, Thorn Farm, Danbury, near Chelmsford, Essex.
A.A.	Turcan, R. D. ...	Orchard Farm, Rodmersham, Kent.
A.A.	Turner, E. ...	Government of Northern Ireland, Ministry of Agriculture, Stormont, Belfast, Ireland.
A.A.	Turner, E. H. ...	c/o New Zealand Fruit Board, Lloyds Bank Chambers, 2 Henrietta Street, London, W.C.2.
A.Fe.	Twyman, G. & Son, Ltd. ...	1 & 2 St. George's Place, Canterbury, Kent.
A.A.	Udall, Miss E. ...	The Orchard, Yalding, near Maidstone, Kent.
A.A.	Udall, S. ...	The Orchard, Yalding, near Maidstone, Kent.
Fo.	United Potash Co., Ltd. ...	Fenton House, 112 Fenchurch Street, London, E.C.3.
A.A.	Vanwyngaerden, A. ...	Ecole Moyenne d'Horticulture de L'Etat, 114 Avenue de Bavay, Vilvorde, Belgium.

A.	Vaux, G. C. ...	19 Collingwood Road, Witham, Essex.
Fe.	Veitch & Sons ...	Royal Nurseries, New North Road, Exeter.
Fo.	Vinson, A., Exors. of ...	Parsonage Farm, Belvedere, Kent.
A.	Vinson, E. ...	Kemsdale, Faversham, Kent.
	*Vinson, Edwin ...	High Croft Hall, Swanley, Kent.
Fo.	Vinson, H. ...	Hurst Farm, Bexley, Kent.
Fe.	Vinson, O. ...	Ruxley Farm, North Cray, Kent.
Fo.	Vinson, R. ...	Nettlestead Court, Wateringbury, Kent.
	*Vinson, W. ...	Hall Place, Barming, near Maidstone, Kent.
A.	Vint, C. ...	Drakes Broughton, Pershore, Worcester.
A.A.	Voeux, H. A. des ...	Battramsley Close, near Lymington, Hants.
A.A.	Vogelaar, T. A. ...	Fruitgrower, Krabbendijke, Holland.
A.A.	Voss, W. & Co., Ltd. ...	Carlton Works, Glengall Road, Millwall, London, E.14.
A.Fe.	Wacher, T. Blake ...	2 Upper Bridge Street, Canterbury, Kent.
A.A.	Wailes, Lt.-Col. H. F. ...	Tudor House, Little Horkesley, Colchester, Essex.
A.A.	Wakeley, R. M. ...	Meresborough House, Rainham, Kent.
Fe.	Wakeley Bros. ...	Station Buildings, Rainham, Kent.
A.A.	Walderslade Smallholders ...	Sunnyside, Robin Hood Lane, Walderslade, Kent.
A.A.	Waldron, V. R. ...	Twin Valleys, Horsmonden, Kent.
A.A.	Wale, W. ...	Old Peans, Robertsbridge, Sussex.
A.A.	Walker, Basil S. ...	R.R.4, Victoria, British Columbia.
A.A.	Wallace, W. E., V.M.H. ...	Poplar Farm, Eaton Bray, Dunstable, Bedford.
A.A.	Wallis, W. H. ...	"Triggs," Goudhurst, Kent.
A.A.	Wallis, W. M. ...	Bekesbourne Hill, near Canterbury, Kent.
A.A.	Walmsley, B., C.B.E. ...	Skeynes, Edenbridge, Kent.
A.A.	Walter, E. B. ...	Woodfield, Brenchley, Kent.
Fe.	Warde, Col. Sir Chas. E., Bart., O.B.E., D.L., J.P.	Barham Court, Teston, near Maidstone, Kent.
A.A.	Warnock, J. ...	Garrion Farm, Wishaw, Lanarkshire.
A.A.	Washington, Mrs. ...	Temples Orchard, Crown Hill, Upper Norwood, London, S.E.19.
A.A.	Waterer, J. Sons & Crisp, Ltd. ...	The Floral Mile, Twyford, Berkshire.
A.A.	Waters, F. ...	30 Cattle Market Street, Norwich, Norfolk.
A.	Waters, J. R. N. ...	Fawke Farm, Sevenoaks, Kent.
Fo.	Wates, G. L. ...	Rowhill Grange, Wilmington, near Dartford, Kent.
A.A.	Wates, A. R. ...	91 London Road, Chelmsford, Essex.
A.A.	Watson, E. ...	Sunninglye, Pembury, Kent.
A.A.	Watson, T. A. ...	Tollands, Kirdford, near Billingshurst, Sussex.
Fe.	Watson, W. & Son ...	Growers of Fruit Trees, Killiney, Co. Dublin, Ireland.
A.A.	Way, Mrs. M. G. D. ...	Dodpits, Yarmouth, Isle of Wight.
A.A.	Way, W. B. ...	Dodpits, Yarmouth, Isle of Wight.
A.A.	Wayland, Lt.-Col. Sir W. A., Kt., J.P., F.C.S., F.S.A., M.P. ...	Hempton Lodge, Monks Horton, Sellindge, Ashford, Kent.
A.	Weald of Kent Farmers' Club	Hancocks Farm, Cranbrook, Kent.
A.A.	Webb, F. J. ...	Shirley, Hartlip, near Sittingbourne, Kent.
A.A.	Webb, R. E. ...	Marlbrook, Bromsgrove, Worcs.
A.A.	Webb, V. C. ...	Larkhall Nurseries, Fordham, Ely, Cambs.
Fo.	Weeks & Son ...	Perseverance Iron Works, Maidstone, Kent.
A.A.	Weir, Major-Gen. G. A., C.B., C.M.G., D.S.O. ...	King's End, Powyke, Worcester.
A.Fo.	Wellington, Capt. R. ...	Worth, Hele, Bradninch S.O., Devon.
Fe.	West, Samuel ...	Ewhurst Place, Hawkhurst, Kent.
A.	Westacott, P. ...	Turvins Farm, Cheveney, Kent.
A.A.	Westendarp, C. G. ...	Broomvale Farm, Great Blakenham, Suffolk.
A.	Western, Capt. F. ...	Scraces, Barming, near Maidstone, Kent.
A.A.	Weston, Major C. F. R. N., M.C. ...	Weston Estate Farm, Tuesnoad, Bethersden, Kent.
Fe.	Westons (Kent), Ltd. ...	The Rocks, East Malling, Kent.
A.A.	Westralian Farms, Ltd. ...	Perth, Western Australia.
A.A.	Wetterstrand, G. A. ...	Sotherton Fruit Farm, Halesworth, Suffolk.
Fe.	Wharton, John ...	Boughton Colemers, Matfield, Kent.
A.A.	Wheeler, J. P. ...	Bockingfold, Marden, Kent.
A.	Wheeler, L. ...	Bockingfold, Marden, Kent.
A.A.	Wheldon, P. ...	Newton Leys, Sudbury, Suffolk.
Fo.	Whitbread & Co., Ltd. ...	Beltring, Paddock Wood, Kent.

A.A.	White & Hiller ...	Dunnington Heath Farm, Alcester, Warwickshire.
Fe.	Whitebread, A. E. ...	The Mount, Wainscott, Rochester, Kent.
A.Fe.	Whitehead, J. A. ...	Messrs. Copo, Ltd., Cockayne Hatley, Potton, Beds.
A.Fe.	Whitmore, Col. F. H. D. C., C.M.G., D.S.O., T.D., D.L., J.P. ...	Orsett Hall, Orsett, Grays, Essex.
A.A.	Whittome, J. E. ...	Turnham's Gill, Henfield, Sussex.
A.A.	Wickham, B. E. ...	Combourne, Goudhurst, Kent.
Fe.	Wickham, G. H. ...	Kenward Farm, Yalding, Kent.
A.A.	Wickham, R. D. ...	The Gate House, Brenchley, near Tonbridge, Kent.
A.A.	Wigan, L. G. ...	Clare Cottage, East Malling, Kent.
A.A.	Wigan, W. L. ...	Clare Cottage, East Malling, Kent.
A.A.	Williams, A. M. ...	Warrington Park, Launceston, Cornwall.
A.A.	Williams, Glynne ...	Hailey, Ipsden, Oxford.
A.A.	Wilson, A. B. Scott ...	Saxon's Hill, Horley, Surrey.
A.A.	Wilson, Miss A. P. ...	116 Fellows Road, Hampstead, London, N.W.3.
A.A.	Wilson, E. J. ...	Foxbury Farm, Stone Street, near Sevenoaks, Kent.
A.A.	Wilson, J. E. B. ...	Downgate, Sandhurst, Kent.
A.A.	Wilson, W. Rodney ...	The Freight, Cranbrook, Kent.
A.	Wilthew, W. R. ...	The Court Lodge, Egerton, Kent.
A.A.	Wimshurst, T. E. ...	Tibbs Court, Brenchley, Kent.
Fe.	Winch, W. H. & Sons ...	Stone Street, Cranbrook, Kent.
A.A.	Wiseman, E. & Sons, Ltd. ...	Farmers and Fruit Growers, Haughley, Suffolk.
A.	Wittersham Branch, N.F.U.	The Boundary, Wittersham, Kent.
Fo.	Wolmer, The Rt. Hon. Viscount, P.C., M.P. ...	Blackmoor, Liss, Hampshire.
Fo.	Wood, M. S. ...	Beacon House, Green Street Green, Dartford, Kent.
A.A.	Wood, T. & Sons ...	The Mount Offices, Farningham, Kent.
Fe.	Wood, W. F., J.P. ...	Chekes Court, Sittingbourne, Kent.
A.A.	Wood, W. J. & A. D. ...	Teynham Court, near Sittingbourne, Kent.
A.Fe.	Woodbridge Canning Co., Ltd. ...	Woodbridge, Suffolk.
Fo.	Woodward, D. & K. ...	Farmers, Longfield Hill, Dartford, Kent.
A.A.	Wootton, H. A., B.Sc., N.D.H. ...	Wannock Gardens, Polegate, Sussex.
A.A.	Wordsworth, R. G. ...	c/o Lloyds Bank, 6 Pall Mall, London, S.W.1.
Fo.	Worshipful Company of Fruiterers ...	40 Chancery Lane, London, W.C.2.
A.A.	Wright, G. ...	Paddock Wood House, Paddock Wood, Kent.
A.A.	Wright, J. L. ...	Fant Farm, Maidstone, Kent.
A.	Wyldbore, T. ...	Dounhurst, Wisborough Green, Sussex.
A.A.	Yapp, W. J. ...	Beech Hurst, Haywards Heath, Sussex.
A.A.	Yates, A. ...	40 High Street, Little Lever, near Bolton, Lancs.
A.A.	Youngman, H. P. ...	Red House, Charsfield, Woodbridge, Suffolk.
A.Fe.	Youngman, W. H. ...	Charsfield, Woodbridge, Suffolk.